PB-293 184

A DIRECTORY OF

COMPUTER SOFTWARE APPLICATIONS

Mathematics

1970-April, 1979

NTIS U.S. DEPARTMENT OF COMMERCE—National Technical Information Service

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COMPUTER SOFTWARE APPLICATIONS

Mathematics

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U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
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16. Abstract (Limit: 200 words)

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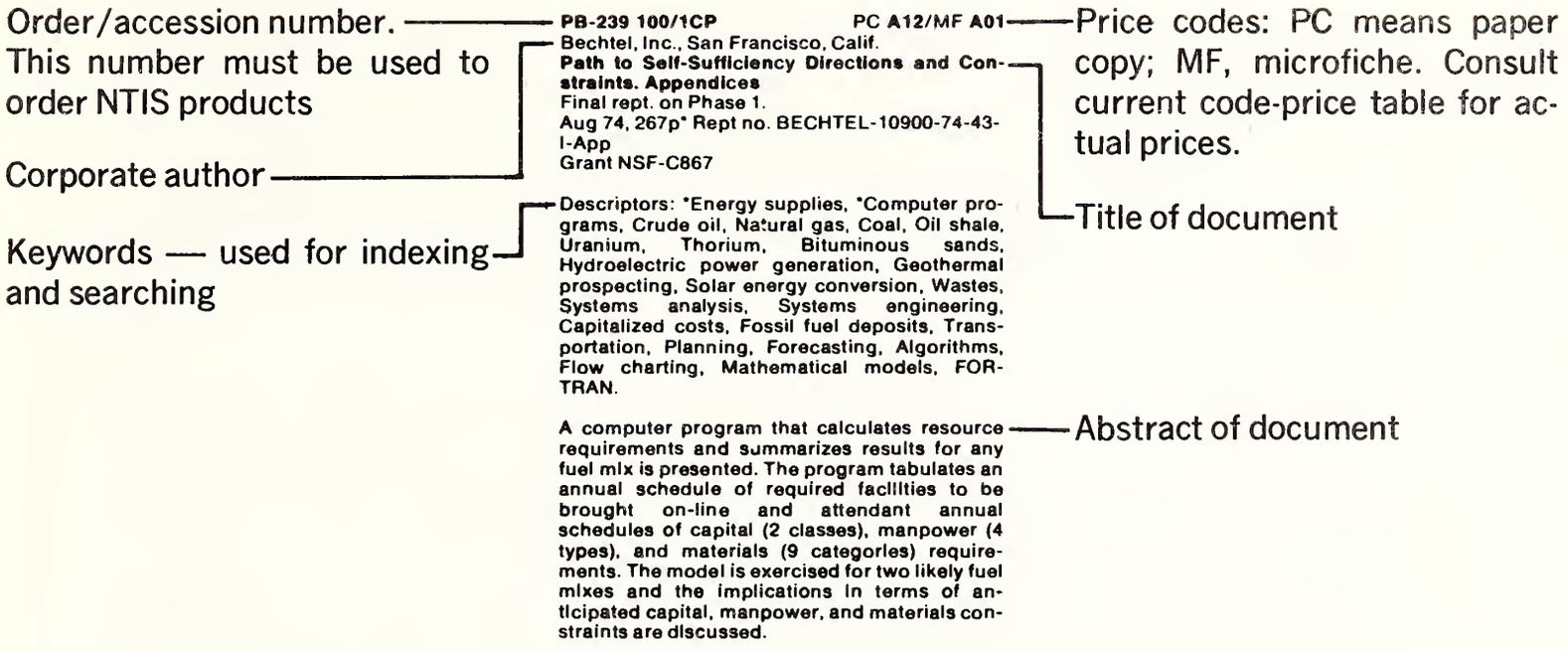

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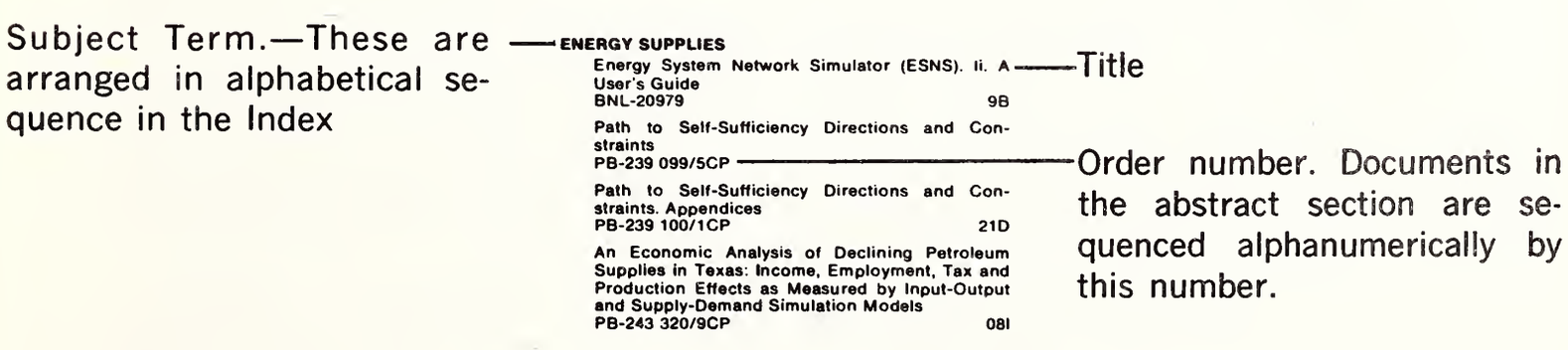

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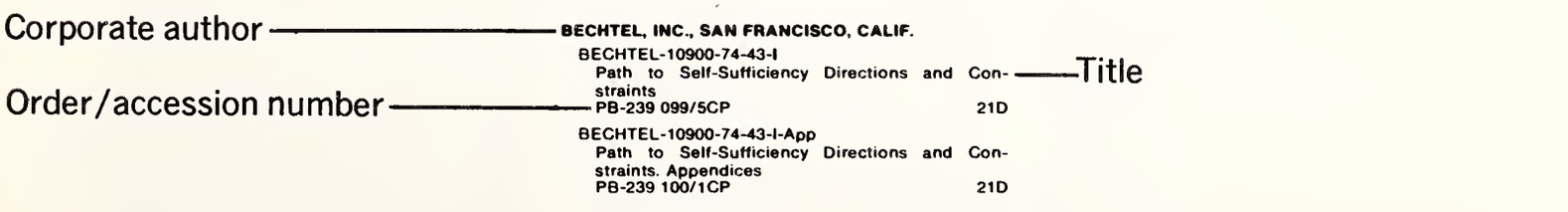

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A13	11.00	E13	28.00	T13	675.00
A14	11.75	E14	31.00	T14	750.00
A15	12.00	E15	34.00	T15	800.00
A16	12.50	E16	37.00	T16	850.00
A17	13.00	E17	40.00	T17	900.00
A18	13.25	E18	45.00	T18	950.00
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MATHEMATICS

AD-A000 396/2CP PC **A04**/MF **A01**
California Univ San Diego La Jolla Dept of Mathematics
A Stable Variant of the Secant Method for Solving Nonlinear Equations
Interim rept.
W. B. Gragg, and G. W. Stewart. Apr 74, 59p
AFOSR-TR-74-1668
Grant AF-AFOSR-2006-71
Prepared in cooperation with Carnegie-Mellon Univ., Pittsburgh, Pa. Contract N00014-67-A-0128-0018.

Descriptors: *Nonlinear algebraic equations, Approximation, Interpolation, Computations, Algorithms, Computer programs, Matrices(Mathematics), FORTRAN.
Identifiers: *Secant method.

The usual successive secant method for solving systems of nonlinear equations suffers from two kinds of instabilities. First the formulas used to update the current approximation to the inverse Jacobian are numerically unstable. Second, the directions of search for a solution may collapse into a proper affine subspace, resulting at best in slowed convergence and at worst in complete failure of the algorithm. In this report it is shown how the numerical instabilities can be avoided by working with factorizations of matrices appearing in the algorithm. Moreover, these factorizations can be used to detect and remedy degeneracies among the directions. A second part of this report documents and lists a program implementing the algorithm described in the first part. (Author)

AD-A000 655/1CP PC **A03**/MF **A01**
Ballistic Research Labs Aberdeen Proving Ground Md
FNFIT: An East-to-Use, Arbitrary Function-to-Data Fitting Routine (A User's Manual)
Final rept.
J. Terrence Klopcic. Aug 74, 41p Rept no. BRL-MR-2402

Descriptors: *Computer programming, *Functions(Mathematics), *Curve fitting, Computer programs, Iterations, Instruction manuals, FORTRAN.
Identifiers: FNFIT computer program.

The program FNFIT uses both steepest gradient, and chi-square minimization searches to fit a user-chosen, arbitrary (including nonlinear) function to a set of input data points. Options are included to allow control of the search for particularly pathological functions, making the program quite versatile. However, the program can also be run without the options, providing an easy-to-learn-and-use tool for the pedestrian. (Author)

AD-A000 897/9CP PC **A03**/MF **A01**
Mathematical Applications Group Inc Elmsford N Y
Extensions and Adjuncts to the BRL-COMGEOM Program
Final rept. Sep 72-Dec 73
Joan Brooks. Aug 74, 45p MR-7035, BRL-CR-177
Contract DAAD05-72-C-0101

Descriptors: *Computer programming, *Combinatorial analysis, *Geometry, Computerized simulation, Matrices(Mathematics), Surfaces, Ray tracing.
Identifiers: BRL-COMGEOM computer program.

The tasks completed under this contract and described in the report are: (1) The addition to the list of available body types of two new bodies, the general ellipsoid and the 'arbitrary quadric surface'; (2) The development of a geometry preprocessor program capable of producing GIFT input from a more limited, user-oriented, set of descriptions; (3) Development of a BRL-COMGEOM model of the M109A1 tank. The first two tasks are described in some detail. The modeling task is embodied in an input deck for the GIFT code and is described briefly in the last section.

AD-A001 128/8CP PC **A02**/MF **A01**
Princeton Univ N J Dept of Statistics
Spline Functions in Data Analysis
Technical rept.
R. S. Anderssen, P. Bloomfield, and D. R. McNeil. Oct 74, 19p Rept no. TR-69-Ser-2
Contract N00014-67-A-0151-0017, AF(11-1)-2310

Descriptors: *Splines, *Approximation, *Demography, Interpolation, Least squares method, Fertility, Mathematical models, Computer programs.
Identifiers: *Spline approximation, Spline interpolation.

This paper discusses the approximation of non-exact data by smooth functions. It is shown that optimal approximations for a large class of criteria are spline functions, and that a sub-class of these are resistant to the presence of gross errors in the data. A computational procedure for obtaining the optimal splines is described and illustrated on a set of demographic data. A listing of an APL program implementing the procedure is included.

AD-A001 247/6CP PC **A04**/MF **A01**
Naval Postgraduate School Monterey Calif
A Computer Code for Solving Medium Sized Non-Linear Programming Problems by the Method of Feasible Directions
Master's thesis
James Douglas Harrison. Sep 74, 70p

Descriptors: *Nonlinear programming, *Computer programs, Functions(Mathematics), Convex sets, Computations, Optimization, Theses, FORTRAN.
Identifiers: FEASBL computer code, Constraints.

A computer code, FEASBL, is developed to maximize a non-linear objective function over a convex feasible region. The feasible region is defined by a set of non-linear and linear constraints on the variables. FEASBL can solve problems involving up to fifty variables with a feasible region formed by up to fifty non-linear constraints, and fifty linear constraints. FEASBL uses a feasible direction method as its solution algorithm. (Author)

AD-A001 257/5CP PC **A05**/MF **A01**
Naval Postgraduate School Monterey Calif
Robust Parameter Estimator for Non-Linear Growth Curves
Master's thesis
Lim Lay Giok. Sep 74, 86p

Descriptors: *Sampling, *Estimates, Least squares method, Approximation, Analysis of variance, Curve fitting, Computer programs, Theses.
Identifiers: Parameter estimation, Robust procedures, Huber method.

The parameter estimation methods considered in this thesis are the weighted Least-Squares and Weighted Huber for some non-linear growth models. The properties of these parameter estimators derived from simulated data by means of (1) weighted and unweighted least-squares and (2) weighted and unweighted Huber robust estimation are compared. The error components of the simulated data are long-tailed and non-normal. The performance of mis-specified models is considered. (Author)

AD-A001 269/0CP PC **A03**/MF **A01**
Naval Ordnance Lab White Oak Md
The Box Optimization Method
Technical rept.
Kenneth D. Shere. 23 Sep 74, 29p Rept no. NOLTR-74-167

Descriptors: *Functions(Mathematics), *Optimization, *Computer programs, Algorithms, Search theory, Computations.

A computer program is presented together with a discussion of the methodology for determining the maximum of a function by a search procedure. This program does not use derivatives or finite difference representation of derivatives. The function may depend on several variables (up to about 30) and there may exist side constraints.

AD-A002 194/9CP PC **A03**/MF **A01**
Naval Research Lab Washington D C
Routines for the Evaluation of Definite Integrals
Final rept.
J. P. Boris. Oct 74, 26p Rept no. NRL-MR-2918

Descriptors: *Integral transforms, *Numerical integration, Computer programs, FORTRAN.
Identifiers: GLINT computer program, DEFINT computer program, IBM 360 computers, IBM 370 computers.

This report describes two computer function subroutines for the numerical evaluation of definite integrals over a specified finite range of integration.

AD-A002 197/2CP PC **A03**/MF **A01**
Naval Research Lab Washington D C
Numerical Evaluation of Oscillatory Integrals with Specific Application to the Modified Bessel Function (K sub I, zeta) (x)
Final rept.
Jay P. Boris, and Elaine S. Oran. Oct 74, 28p Rept no. NRL-MR-2925

Descriptors: *Integral transforms, *Bessel functions, *Numerical integration, Fourier analysis, Computer programs, FORTRAN.
Identifiers: IBM 360/91 computers.

The authors present an orthogonalized Fourier method for the numerical evaluation of oscillatory integrals which have an infinite range of integration. This method in contrast to others which have been developed, attains maximum efficiency in the limit of rapid oscillations. The results are compared to those obtained from a Gaussian integration scheme and the Shanks acceleration of the Gaussian results. Special attention is given to the evaluation of the modified Bessel Function (K sub i, zeta) (x).

AD-A002 303/6CP PC **E01**/MF **A01**
Northwestern Univ Evanston Ill Dept of Civil Engineering
Direct Search Optimization Method
Ying-San Lai, and Jan D. Achenbach. 25 May 72, 14
Availability: Pub. in Jnl. of the Structural Div., ASCE, Paper 9470 v99 nST1 p19-31 Jan 73.

Descriptors: *Nonlinear programming, *Cantilever beams, *Optimization, *Structural engineering, Statics, Mechanics, Stresses, Computer programs, Structural members, Frames, Search theory, Moments, Iterations, Elastic properties, Computer applications, Mathematical prediction, Reprints.
Identifiers: Direct search optimization method.

A direct search method has been presented with a particular view towards optimization problems for which the design variables are discrete in nature. The method should, however, also be very useful when the objective function is the output of a computer program, or if the objective function is too complicated for an analytical treatment of the optimization problem. Three examples of structural optimization have been considered: two static problems and one dynamic problem. For the two static problems, the results obtained by other authors have been reproduced.

AD-A002 931/4CP PC **A09**/MF **A01**
Naval Research Lab Washington D C
Direct Methods for Solving Systems of Linear Equations, Involving Toeplitz or Hankel Matrices
Final rept.
John J. Cornyn, Jr. Oct 74, 197p Rept no. NRL-MR-2920

Descriptors: *Matrices(Mathematics), *Computer programs, *Computations, Numerical methods and procedures, Fourier transformation, Partial differential equations, Linear algebraic equations, FORTRAN, Theses.
Identifiers: Toeplitz matrices, Hankel matrices, Fast Fourier transform.

Some direct methods for solving systems of linear equations involving nonsingular block and scalar

Toeplitz or Hankel matrices are considered. These methods include: the use of the discrete and fast Fourier transforms for left and right q-circulant linear systems, Trench's inversion algorithms and Cholesky's and Rissanen's triangular decomposition algorithms.

AD-A003 190/6CP PC **A03**/MF **A01**
Ballistic Research Labs Aberdeen Proving Ground Md
SYMBOLANG - A Slip Extension for Algebraic Manipulation
M. A. Hirschberg. Nov 74, 28p Rept no. BRL-1749

Descriptors: *Computer programming, *Algebra, *Computations, Arithmetic, FORTRAN.
Identifiers: SYMBOLANG computer code, BRLESC 2 computer, Symbolic programming, List processing.

SYMBOLANG, originally developed by A. Lapidus, M. Goldstein, S. Hoffberg, and expanded by H. Bernstein, S. Greenspan, A. Magnus, and others is a collection of FORTRAN-callable subroutines which can perform arithmetic operations (addition, subtraction, multiplication, division, etc.), substitutions, evaluations, and differentiations on expressions represented as SLIP lists. SYMBOLANG consists of seventy-two subprograms and is operational on the BRLESC 2 computer.

AD-A003 355/5CP PC **A05**/MF **A01**
Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering
A Quadratic Programming Algorithm Which Uses Generalized Inverses
Master's thesis
David R. Czaplicki. Dec 74, 93p Rept no. GSA/SM/74D-2

Descriptors: *Quadratic programming, Computer programs, Inequalities, Matrices(Mathematics), Algorithms, Theses.
Identifiers: Constraints.

An algorithm for solving quadratic programming problems is described in this study. A quadratic programming problem here is defined as finding the maximum of a quadratic function of several variables where the variables are subject to linear equality and inequality constraints. The quadratic function is restricted to be strictly concave. The algorithm uses generalized inverses of matrices to sort through the constraints in order to find quickly the set of constraints that is binding in the final solution. The algorithm is then compared to other existing quadratic programming algorithms.

AD-A003 703/6CP PC **A03**/MF **A01**
Wisconsin Univ Madison Mathematics Research Center
A Smooth and Local Interpolant with 'Small' k-th Derivative
Summary rept.
Carl de Boor. Dec 74, 40p Rept no. MRC-TSR-1466
Contract DA-31-124-ARO-D-462

Descriptors: *Interpolation, Computations, Finite difference theory, Inequalities, Polynomials, Approximation, Computer programs, FORTRAN.

This report is a continuation of MRC TSR 1425, 'How small can one make the derivatives of an interpolating function.', and is concerned with estimating the number (K sub 0) := inf C sub k with the infimum taken over all C sub k. Knowledge about (K sub 0)(k) makes it possible to estimate the derivatives (up to and including the k-th) of some smooth interpolant to give data directly from the divided differences of the data without actually constructing such an interpolant and its derivatives, thus facilitating the process of estimating the residual error of a finite difference approximation.

AD-A003 855/4CP PC **A04**/MF **A01**
Ballistic Research Labs Aberdeen Proving Ground Md
Description and Comparison of the K Method for Performing Numerical Integration of Stiff Ordinary Differential Equations
M. D. Kregel, and E. L. Lortie. Jul 74, 68p Rept no. BRL-1733

Descriptors: *Differential equations, *Numerical integration, Matrices(Mathematics), Computer programs, Ionosphere, Chemical reactions.
Identifiers: *Stiff differential equations, K matrix.

A numerical integration method, termed the K method, has been developed within the Concepts Analysis Laboratory for the integration of about fifty stiff ordinary differential equations. This method is described and, by the use of several benchmark sets of ordinary differential equations, comparisons are made with other methods that have been described in the open literature. Instructions are given on the use of the K method, and a complete listing of the method is included.

AD-A003 928/9CP PC **A06**/MF **A01**
George Washington Univ Washington D C Program in Logistics
Some New Results in the Statistical Analysis of Stochastic Processes of the Reliability and Queuing Type
Doctoral thesis
T. R. Thiagarajan. 8 Oct 74, 111p
Contract N00014-67-A-0214

Descriptors: *Stochastic processes, *Statistical analysis, Reliability, Queueing theory, Prisoners, Behavior, Computer programs, Mathematical prediction, Theses, FORTRAN.
Identifiers: Correctional reforms.

This dissertation deals mainly with the usefulness of Gnedenko's F or ratio test for exponentiality with a stress on its application to the Weibull distribution. The power of the Gnedenko ratio test is calculated for the oft-used alternatives of Erlang and log-normal distributions and then compared to that of the appropriate Kolmogorov-Smirnov, Anderson-Darling, and other distance statistics. A second and important application is made in the field of queuing theory. Given the line waits of an M/G/1 queue, how does one test the hypothesis that G = M in the notation of queuing. This problem is fully solved.

AD-A004 207/7CP PC **A04**/MF **A01**
Carnegie-Mellon Univ Pittsburgh Pa Dept of Computer Science
Efficient Methods for Finding Zeros of Functions Whose Derivatives are Easy to Evaluate
Interim rept.
Richard Brent. Dec 74, 66p
Contract N00014-67-A-0314-0010, Grant NSF-GJ-32111
Prepared in cooperation with Australian National Univ., Canberra. Computer Centre.

Descriptors: *Functions(Mathematics), *Approximation, *Iterations, Differential equations, Runge Kutta method, Computer programs, FORTRAN.
Identifiers: Zerofinding, Zeroes, *Roots of equations.

Some multipoint iterative methods without memory for approximating simple zeros of functions of one variable are described. Explicit, nonlinear, Runge-Kutta methods for the solution of a special class of ordinary differential equations may be derived from the methods for finding zeros of functions. Numerical examples and some FORTRAN subroutines are given.

AD-A004 245/7CP PC **A04**/MF **A01**
Naval Postgraduate School Monterey Calif
The Performance Characteristics of Some Reliability Growth Model
Technical rept. Jan-Dec 74
T. Jayachandran, and L. R. III Moore. Dec 74, 51p Rept no. NPS-53Jy74122

Descriptors: *Reliability, Monte Carlo method, Mathematical models, Computerized simulation, Computer programs, Failure, FORTRAN, Exponential functions.
Identifiers: Growth models, Maximum likelihood estimation, Parameter estimation, Exponential density functions.

A reliability growth model is an analytical model that accounts for changes in reliability due to design changes and other corrective actions taken during the development and testing phases of a reliability program. This paper describes the results of a Monte Carlo study comparing the performance characteristics of four reliability growth models that have been proposed in the reliability literature.

AD-A004 632/6CP PC **A02**/MF **A01**
Maryland Univ College Park Computer Science Center
The Economical Storage of Plane Rotations
Technical rept.
G. W. Stewart. Nov 74, 11p Rept no. TR-342
Contract N00014-67-A-0239-0037

Descriptors: *Matrices(Mathematics), *Transformations(Mathematics), *Computer programs, Rotation, FORTRAN, Linear algebraic equations, Numerical analysis.
Identifiers: Givens transformation.

The object of this note is to describe how plane rotations can be economically represented on a computer. Plane rotations, which have long been used in matrix computations to annihilate selected elements of a matrix, have the drawback that their definition requires two numbers. In this note it is shown how this information may be stably compacted into a single number. An appendix lists FORTRAN programs for solving linear equations which illustrate the technique described in the body of the note.

AD-A005 228/2CP PC **A04**/MF **A01**
Letterman Army Inst of Research San Francisco Calif
Program Posthoc: Balanced One-Way Independent-Groups or Repeated-Measures Analysis of Variance with Post-Hoc Dunnett, Newman-Keuls or Scheffe Mean Comparisons
Ray T. Sterner, James T. Wheeler, and Lavern F. Krabill. Nov 74, 61p Rept no. LAIR-25

Descriptors: *Analysis of variance, *Computer programs, Statistical tests, Computations, FORTRAN, Instruction manuals.
Identifiers: POSTHOC computer program, FORTRAN 4 programming language, CDC 6400 computers.

User instructions for the operation of a FORTRAN 4 program (i.e., POSTHOC) to compute balanced one-way independent-groups or repeated-measures analysis of variance and either Dunnett, Newman-Keuls or Scheffe post-hoc means comparisons are described.

AD-A005 470/0CP PC **A04**/MF **A01**
Naval Postgraduate School Monterey Calif
Some Alternative Methods to Stepwise Regression for the Screening of Variables
Master's thesis
Dennis George Lambell. Dec 74, 55p

Descriptors: *Regression analysis, Matrices(Mathematics), Sampling, Random variables, Eigenvectors, Computer programs, Theses.

This paper addresses the problem of screening potential variables for entrance in a linear multiple regression setting. The purpose of the work presented here is to propose two screening methods, both of which have roots in principle component analysis, and which evaluate a combination of variables in an efficient enough manner so that enumeration of all combinations is feasible even when the number of potential variables is quite large. Using the square of the multiple correlation coefficient as the criterion, the selections made by these methods in several test cases are evaluated, and compared with the selections made by the methods of total enumeration and stepwise regression. The paper concludes with overall evaluations of the two methods and suggests directions for further study.

AD-A005 585/5CP PC **A04**/MF **A01**
Army Missile Research Development and Engineering Lab Redstone Arsenal Ala Guidance and Control Directorate
Digital Computer Program for the Determination of Modified Z-Transforms with W-Plane Transformation
Technical rept.
Edward E. Herbert, and Bettye Rogerson. 1 Dec 74, 75p Rept no. RG-75-20

Descriptors: *Laplace transformation, *Control theory, *Computer programming, Complex variables, Transfer functions, Computer programs.
Identifiers: Sampled data systems.

In the analysis of sampled-data control systems containing transport lags due to computational delay of the controller and/or the actuator mechanism, the modified z-transforms are frequently used. This computer program breaks down the La-Place transform transfer function of the system into a sum of partial fractions and computes the modified z-transform of each term. Each term is then mapped into the W-plane by the bilinear transformation z = (1 + W)/(1 - W). This technique allows the control system designer to use conventional classical methods of continuous systems on the W-plane transfer function. The poles and zeros of the W-place are then mapped back into z by inverse transformation. The program listing is included.

AD-A005 644/0CP PC **A07**/MF **A01**
Wyoming Univ Laramie Statistics Lab
Confidence Intervals for the Difference of Two Proportions: Small Sample Sizes
Technical rept.
Lyman L. McDonald, Kenneth D. Neubauer, and Keren A. Meister. Oct 74, 126p Rept nos. 2009, RP-44
Contract N00014-70-A-0266-0010

Descriptors: *Sampling, *Confidence limits, Distribution functions, Computer programs, FORTRAN, Tables(Data).
Identifiers: Confidence level, FORTRAN 4 programming language.

Confidence intervals, with confidence levels > or = 90, 95 and 99 percent are tabulated for the difference of two proportions under independent binomial sampling. All possible sample sizes up to and including 12 are considered, as well as selected cases for sample sizes from 13 to 15. The listing of a FORTRAN 4 computer program is given which will generate confidence intervals for other cases.

AD-A005 916/2CP PC **A02**/MF **A01**
California Univ Berkeley Electronics Research Lab
Computation of Functions of Trianguiar Matrices
Final rept.
B. N. Parlett. Nov 74, 22p Rept no. ERL-M481
Contract N00014-69-A-0200-1017

Descriptors: *Matrices(Mathematics), Functions(Mathematics), Eigenvectors, Computations, Algorithms, Computer programs.
Identifiers: *Triangular matrices, Canonical forms.

A simple relation exists among the elements of phi(T) when phi is an analytic function and T is triangular. This permits the rapid build up of phi(T) from its diagonal. An analogous relation holds for block triangular matrices. This permits the formation in real arithmetic of real functions of real matrices with complex eigenvalues. The confluent case is included. Algorithms are given some numerical examples.

AD-A006 478/2CP PC **A05**/MF **A01**
Army Materiel Command Texarkana Tex Intern Training Center
A Development and Analysis of Multiple-Range Techniques for Controlling the Variability of a Process Characteristic with a Uniform Distribution
Final rept.
Richard Dan Abeyta. May 74, 97p Rept no. USAMC-ITC-02-08-73-201

Descriptors: *Quality control, *Statistical analysis, *Sampling, Probability density functions, Normal density functions, Computer programs, Numerical integration.
Identifiers: *Statistical quality control, *Acceptance sampling, Order statistics.

The Shewhart range chart is the most commonly used method of controlling process variability. The statistic plotted on this chart is the outer range of values of random samples from a repetitive process. As an extension of the use of ranges, the primary objective of this research is the development of quality control techniques in which two ranges are computed rather than just one. It is anticipated that two ranges provide more information and consequently are more discriminating at the expense of only a slight increase in necessary calculations. Several multiple-range plans and a single range plan are developed for random samples of size four from a uniform distribution. In each case, expressions for alpha and beta errors are derived. The operating characteristic (O.C.) curve, which is a plot of beta error against actual process variation, for a specified alpha level, is the principle criterion of comparison. The plan with the lowest overall O. C. curve is the most discriminating and consequently the most desirable. The conclusion drawn from this analysis is that multiple-range plans have no increase in discriminating ability over single range plans for samples of size four from a uniform distribution.

AD-A006 666/2CP PC **A03**/MF **A01**
Naval Postgraduate School Monterey Calif
LPI--An Interactive Linear Programming Package
R. H. Shudde. Oct 74, 42p Rept no. NPS-55SU741001

Descriptors: *Linear programming, *Computer programs, Simplex method, Computations, FORTRAN.
Identifiers: IBM 360 computers, FORTRAN 4 programming language, Sensitivity analysis.

LPI is an interactive linear programming (L.P.) package designed primarily for instructional usage with the Cambridge Monitor System on the IBM/360 Computer. LPI removes the computational burden from the student without depriving him of the decision-making processes necessary for the successful solution of a L.P. LPI is self-instructing as to its own use; a minimum of CP/CMS commands are required to interface the student with LPI. LPI will allow primal simplex and/or dual simplex pivoting; sensitivity analysis of the 'cost' coefficients and the 'requirement' coefficients; the Separable Programming Algorithm; and the Wolfe Quadratic Programming Algorithm.

AD-A006 812/2CP PC **A03**/MF **A01**
Wisconsin Univ Madison Mathematics Research Center
Butterworth - and Chebyshev-Related Splines
Technical summary rept.
Rui J. P. de Figueiredo. Feb 75, 30p Rept no. MRC-TSR-1327
Contract DA-31-124-ARO(D)-462, Grant NSF-GK-36375

Descriptors: *Splines, *Approximation, Differential equations, Complex variables, Functional analysis, Theorems, Computer programs.
Identifiers: *Butterworth splines, *Chebychev splines, *Spline approximation.

Two generalized splines, called respectively Butterworth and Chebyshev splines, are introduced; a constrained minimum norm property of a general class of splines (Butterworth- and Chebyshev-related splines) to which they belong is stated; and a motivation for their introduction is provided.

AD-A007 014/4CP PC **A02**/MF **A01**
North Carolina Univ Chapel Hill Graduate School of Business Administration
An Efficient Heuristic Procedure for the Capacitated Warehouse Location Problem
Basheer M. Khumawala. 1974, 16p
Availability: Pub. in Naval Research Logistics Quarterly, v21 n4 p609-623 Dec 74.

Descriptors: *Heuristic methods, *Computer programming, *Warehouses, *Integer programming, *Naval logistics, Industrial plants, Site selection, Mathematical analysis, Computer programs, Algorithms, Reprints.

This paper introduces an efficient heuristic procedure for solving a special class of mixed integer programming problem called the capacitated warehouse (plant) location problem. This procedure parallels the work reported earlier on the uncapacitated warehouse location problem. The procedure can be viewed as tracing a judiciously selected path of the branch and bound tree (from the initial node to the terminal node) to arrive at a candidate solution. A simple backtracking scheme is also incorporated in the procedure to investigate possible improvement in the solution. Computational results on the problems found in the literature look quite encouraging. (Author)

AD-A007 021/9CP PC **A02**/MF **A01**
Air Force Academy Colo
Efficient Computational Devices for the Capacitated Transportation Problem
Robert W. Langley, Jeff Kennington, and C. M. Shetty. 1975, 12p
Availability: Pub. in Naval Research Logistics Quarterly, v21 n4 p637-647 Dec 74.

Descriptors: *Transportation, *Linear programming, *Algorithms, Computer programs, Machine coding, Networks, Problem solving, Reprints.
Identifiers: Resource allocations.

This paper presents the details for applying and specializing the work of Ellis Johnson and to develop a primal code for the well-known capacitated transportation problem. The code was developed directly from the work of Johnson, but is similar to codes developed by Glover, Karney, Klingman, and Napier and Srinivasan and Thompson. The emphasis in the presentation is the use of the graphical representation of the basis to carry out the revised simplex operations. This is a means of exploiting the special structure and sparseness of the constraint matrix to minimize computational effort and storage requirements. The results of solving several large problems with the code developed are also discussed.

AD-A007 098/7CP PC **A07**/MF **A01**
Army Materiel Command Texarkana Tex Intern Training Center
Development of a Generalized Computer Program for the Calculation of Some Properties of Order Statistics
Final rept.
James V. O'Brien. Apr 74, 138p Rept no. USAMC-ITC-02-08-73-212

Descriptors: *Sampling, *Normal density functions, Probability density functions, Statistical analysis, Numerical integration, Computer programs, Tables(Data).
Identifiers: *Order statistics.

The objective of this research project is the development of a generalized computer program for use in determining some properties of order statistics. The program is designed primarily for cases in which numerical integration is required. The data to be produced will include tables for the probability density function and cumulative distribution of order statistics. In addition, summarizing tables for the mean value of order statistics, and the values of the variance, skewness and kurtosis of the order statistic probability density functions, cross-indexed by sample size and order statistic, will also be produced. The principal goals of this project are a listing of this generalized program, and sample tables of data produced for order statistics based upon samples drawn from a normally distributed population with mean value equal to zero and variance equal to one.

AD-A007 099/5CP PC **A05**/MF **A01**
Army Materiel Command Texarkana Tex Intern Training Center

An Evaluation of the Bayesian Approach as a Method for Selecting the Prior Probability Distribution
Final rept.
Archie Sonnie Chen. May 74, 77p Rept no. USAMC-ITC-02-08-73-025

Descriptors: *Reliability, *Statistical analysis, *Bayes theorem, Probability density functions, Estimates, Computer programs.
Identifiers: Sensitivity analysis, Gamma function.

This paper presents a discussion of the Bayes' Theorem and its application in reliability estimation. The proposed Bayesian Reliability Demonstration Test Plan based on the inverted gamma distribution is briefly described. To evaluate the errors produced when incorrect assumptions are made on various distribution parameters, a sensitivity analysis method is developed. Two computer programs are used to obtain some results by applying the Bayesian approach and the sensitivity analysis technique.

AD-A007 143/1CP PC **A25**/MF **A01**
Army Materiel Command Texarkana Tex Intern Training Center
Properties of Order Statistics Based Upon the Three Parameter Weibull Distribution
Final rept.
Richard P. McDonnell. Dec 73, 579p Rept no. USAMC-ITC-02-08-73-211

Descriptors: *Weibull density functions, *Sampling, Probability density functions, Computer programs, Tables(Data), Curve fitting, Graphics.
Identifiers: *Order statistics.

This research is designed to develop a set of tables for the cumulative distribution of an order statistic for selected values of n, the sample size and k, the order statistic of interest. This sample size n will be a random sample drawn from a population based upon a three parameter Weibull probability density function. It will be assumed in this paper that the Weibull parameters are known. These tables also contain the median value of the order statistic. A computer program is developed to perform these calculations and also to plot the probability density function of the order statistic for selected values of n, k and beta.

AD-A007 569/7CP PC **A04**/MF **A01**
Naval Ship Engineering Center Philadelphia Pa Philadelphia Div
User's Guide to a New User-Oriented Subroutine for the Automatic Solution of One-Dimensional Partial Differential Equations
Final rept.
A. M. Loeb. 20 Feb 75, 63p Rept no. NAVSECPHILAD-C-69-V

Descriptors: *Partial differential equations, *Numerical integration, *Computer programs, Finite difference theory, FORTRAN, Algorithms.
Identifiers: CDC 6600 computers.

A new user-oriented FORTRAN-based subroutine, called SUBROUTINE PDEI, is introduced, which automatically applies the sliding difference method of lines algorithm to user-supplied FORTRAN code which characterizes the user's particular partial differential equation. To use the new subroutine, the user need not have any special knowledge of the complex numerical analysis techniques required to apply this method of lines algorithm to his problem. Furthermore, the user is not, as with earlier programs of this type, constrained by a 'general' equation or 'generalized' boundary conditions but is able to prepare his problem in free form. The subroutine is capable of handling linear, nonlinear, coupled partial differential equations and partial differential equations coupled to ordinary differential equations or any combination of these. Although presently limited to one spatial dimension, work is in progress to extend application of the method to multiple spatial dimensions.

AD-A007 572/1CP PC **A03**/MF **A01**
Minnesota Univ Minneapolis Dept of Psychology
TETREST: A Fortran IV Program for Calculating Tetrachoric Correlations
Technical rept.
James R. McBride, and David J. Weiss. Feb 75, 44p Rept no. RR-75-2
Contract N00014-67-A-0113-0029
Report on Psychometric Methods Program.

Descriptors: *Computer programs, *Correlation techniques, Sampling, Matrices(Mathematics), Normal density functions, Control sequences, FORTRAN.
Identifiers: TETREST computer program, FORTRAN 4 programming language, *Tetrachoric correlation.

A general purpose computer program for the calculation of a matrix of tetrachoric correlations is described. This program was developed for use in adaptive (and other) testing research for examining the unidimensionality assumption in latent trait theory, in conjunction with available factor analysis programs. Several other potential applications, as well as details for its use, are described. The program accepts as input raw dichotomous data, reduced joint frequency data, or joint and marginal proportions, for up to 75 items. Output options include the tetrachoric correlation matrix, the matrix of phi coefficients, fourfold frequency tables for every item pair, a joint frequency matrix (which reduces all the information in the fourfold tables to a square matrix with order equal to the number of items), and a pair-by-pair listing of input proportions and output correlations which permits testing the program against published tables of the tetrachoric correlation. Variable input and output formatting makes the program convenient to the use in conjunctions with other analyses by packaged statistical programs. Examples of input and output are presented. A complete FORTRAN 4 listing is included.

AD-A008 429/3CP PC **A05**/MF **A01**
Ohio State Univ Columbus Div of Statistics
IRCCRAND - The Ohio State University Random Number Generator Package
Technical rept.
Edward J. Dudewicz. Oct 74, 100p TR-104, ARO-10003.18-M
Grant DA-ARO-D-31-124-72-G55

Descriptors: *Computerized simulation, *Monte Carlo method, Mathematical models, Statistical analysis, Pseudo random systems, Computer programs.
Identifiers: *Random number generators, Floating point operation.

A documented package (IRCCRAND) of random (pseudo-random) number generators for use in simulation and Monte Carlo studies is presented. The documentation is intended to allow intelligent choice of a random number generator by most investigators using simulation methodology.

AD-A008 979/7CP PC **A06**/MF **A01**
University of Southern California Los Angeles Dept of Aerospace Engineering
Interpolative Spline Filters
Interim rept.
Hussein Mohamed Youssef. Jan 75, 101p AFOSR-TR-75-0558
Grant AF-AFOSR-2141-71

Descriptors: *Splines, *Interpolation, Matrices(Mathematics), Differential equations, Integral equations, Computer programs, Theses.
Identifiers: Nonlinear filtering, Spline interpolation.

An optimal phase demodulation problem is resolved by the numerical synthesis of the optimal nonlinear filter. The synthesis is achieved by representing the relevant conditional density of phase and phase rate by multiple dimensional interpolative splines under tension. This realization technique is compared in terms of speed of estimate production, estimate and conditional density accuracy with other realization schemes, point mass cyclic, and Fourier realization. A complete Monte Carlo program for this method is given as well as Monte Carlo performance.

AD-A009 188/4CP PC **A04**/MF **A01**
Army Materiel Command Texarkana Tex Intern Training Center
Normal Characteristics of the Weibull Order Statistic Distribution
Final rept.
James A. Thompson. Mar 75, 62p Rept no. USAMC-ITC-02-08-75-228

Descriptors: *Weibull density functions, *Normal density functions, *Approximation, Standard deviation, Probability density functions, Analysis of variance, Computer programs, Tables(Data).
Identifiers: *Order statistics.

This report developed a technique to measure how closely the Weibull order statistic distribution, for a certain range of its parameters, approximates a normal distribution. This technique used the analytical expressions for the mean and variance of the Weibull order statistic distribution to approximate the mean and variance of the normal distribution. Using these approximations, the standard normal deviates for the 75th, 90th, and 95th percentiles were compared with the actual values to ascertain whether the approximation is acceptable. The acceptance criteria used in this paper is to accept the approximation when each of the errors is less than 10%.

AD-A009 242/9CP PC **A02**/MF **A01**
Yale Univ New Haven Conn Dept of Statistics
Tests of Residuals in the Additive Analysis of a Two-Way Table -- a Suggested Computer Program
Technical rept.
Francis J. Anscombe, Diccon R. E. Bancroft, and William J. Glynn. Nov 74, 16p Rept no. TR-32
Contract N00014-67-A-0097-0014

Descriptors: *Analysis of variance, *Statistical tests, *Regression analysis, Least squares method, Sampling, Computer programs, Distribution functions.
Identifiers: Goodness of fit tests.

After the customary additive analysis of a two-way table has been performed, leading to Fisher's analysis of variance, the residuals can be used to test goodness of fit of the standard linear model. Tests for nonnormality of the errors can be constructed from sums of third and fourth powers of the residuals. Tests for heteroscedasticity can be constructed by doing regression of squared residuals on fitted values or on indicators for rows or columns. Some moments of the test statistics can be found and used in approximate tests. A computer program in APL is shown and illustrated.

AD-A009 410/2CP PC **A07**/MF **A01**
Army Materiel Command Texarkana Tex Intern Training Center
Comparison of Maximum Likelihood and Least Squares Cumulative Estimators for the Gompertz-Makeham Hazard Rate Function
Final rept.
Richard Earl Sackett. Apr 75, 140p Rept no. USAMC-ITC-02-08-75-003

Descriptors: *Reliability, *Statistical analysis, Life tests, Failure, Least squares method, Sampling, Computer programs.
Identifiers: Maximum likelihood estimation, Parameter estimation, Gompertz-Makeham functions, Fletcher-Powell method, Hazard rate functions.

This research investigates the use of the cumulative distribution function and least squares analysis for estimating the three parameters of the hazard function, b + k(e sup(-at)). The least squares cumulative (LSC) estimators of the parameters are obtained by solving a system of nonlinear equations using the gradient method of Fletcher-Powell. The small sample property of the estimator is analyzed in a two-way comparison. Through Monte-Carle simulation, sample data sets with five to twenty-five time-to-failure data points are generated by assuming parameter values. The failure times are used as inputs to the LSC program and the resulting estimates are compared to maximum likelihood estimates.

AD-A009 431/8CP PC **A02**/MF **A01**
College of William and Mary Williamsburg Va Dept of Mathematics
Matrix Bandwidth and Profile Reduction
Technical rept.
H. L. Crane, Jr, Norman E. Gibbs, William G. Poole, Jr, and Paul K. Stockmeyer. May 75, 23p Rept no. TR-8
Contract N00014-73-A-0374-0001, Grant NGR-47-102-001
Prepared in cooperation with Comptek Research, Inc., Hyattsville, Md.

Descriptors: *Computer programs, *Matrices(Mathematics), *Permutations, Subroutines, FORTRAN.
Identifiers: *Sparse matrix, REDUCE computer program, Graph theory.

This program, REDUCE, reduces the bandwidth and profile of sparse symmetric matrices, using row and corresponding column permutations. It is a realization of the algorithm described by the authors elsewhere. It was extensively tested and compared with several other programs and was found to be considerably faster than the others, superior for bandwidth reduction and as satisfactory as any other for profile reduction.

AD-A009 783/2CP PC **A10**/MF **A01**
Massachusetts Inst of Tech Cambridge Operations Research Center
A Cutting Plane Method for the Fixed Cost Problem
Technical rept.
Jean-Marc Rousseau. Mar 75, 213p Rept no. TR-108
Contract DAHC04-73-C-0032

Descriptors: *Linear programming, Scheduling, Transportation, Allocations, Mathematical models, Routing, Algorithms, Computer programs, Theses.
Identifiers: *Cutting plane method, *Fixed costs, Location problems.

The fixed cost linear programming problem (FCLP) refers to a linear programming problem in which each variable incurs a fixed cost or charge, in addition to its linear cost, whenever the variable takes a strictly positive value. The study is devoted to the development of a cutting plane method and its role in the perspective of a general framework (essentially a branch-and-bound) for FCLP algorithms. Analysis of the structure and properties of the problem reveals that algorithms which seek local minimum points (minimum with respect to neighborhood) are almost certain to be non-effective because of the proliferation of these local minima. The cutting plane method developed here (the FCLP cut) comes as the generalization, for the non-convex case, of outer linearization methods used for convex problems. The FCLP cut is developed from a linear under approximation of the FCLP objective function. Convergence properties of the method are studied in depth and sufficient conditions for convergence to a global optimal solution are identified. The most interesting fact is the constructive similarity demonstrated between the Benders and FCLP cuts; they differ only by the space in which they are derived.

AD-A009 795/6CP PC **E02**/MF **A01**
Naval Surface Weapons Center Dahlgren Lab Va
Computer Program for Network Flow Problems
Technical rept.
Doily E. Fulcher, and Eleanor J. Bailey. May 75, 28 Rept no. NSWC/DL-TR-3325

Descriptors: *Network flows, *Computer programs, Computations, FORTRAN, Algorithms.
Identifiers: FORTRAN 4 programming language, CDC 6700 computers, Shortest route method.

The report describes a computer program designed to solve the following network flow problems: maximal flow, shortest route, and minimal cost maximal flow. The information necessary to use the program is given as well as input and output of a sample problem. The solution procedure and the computer respresentation of the network are discussed. A FORTRAN 4 listing of the program as run on the CDC 6700 computer is also presented.

AD-A009 891/3CP PC **A03**/MF **A01**
New Mexico Univ Albuquerque Dept of Mathematics and Statistics
A Subroutine for Generating Pseudo-Random Numbers from a Variety of Distributions
Technical rept.
Charles B. Davis, and William J. Zimmer. Apr 75, 28p Rept no. TR-307
Contract N00014-68-A-0155-0003

Descriptors: *Computer programming, *Pseudo random systems, Computer programs, Probability density functions, Approximation, Computations, FORTRAN.
Identifiers: *Random number generators, *Pseudorandom numbers, FORTRAN 4 programming language.

In this paper, a method for generating pseudo-random numbers is proposed. The method produces good approximations to certain distributions which are difficult to approximate by means of previously published methods. The authors begin by discussing previously published algorithms. Then the authors describe the new algorithm which is given for the case where F, the c.d.f. of the desired distribution, is available as a subroutine but F sup(-1) is not, as is the case with the beta distribution. The FORTRAN 4 code is also provided. This new algorithm preserves qualities of 'randomness' and goodness of fit possessed by the uniform (0,1) random number generator contained in the code. Also presented are results of statistical tests on the generator and instructions for substituting another uniform (0,1) random number generator.

AD-A009 982/0CP PC **A14**/MF **A01**
Naval Postgraduate School Monterey Calif
Semi-Markov Generated Point Processes and the Superposition of Finite Numbers of Independent Erlang and Hyperexponential Renewal Processes
Doctoral thesis
Richard Davies Haskell. Jun 74, 316p

Descriptors: *Stochastic processes, *Multivariate analysis, Time series analysis, Markov processes, Spectrum analysis, Probability density functions, Computer programs, Theses.
Identifiers: *SemiMarkov processes, *Point processes, Renewal processes, Erlang density functions, Exponential density functions.

The objective of this research has been to characterize in terms of spectral representations and interval distributions the univariate point process resulting from the superposition of a finite number of independent, identically distributed renewal processes with either Erlang or hyperexponential interval distributions. A corollary to the direct line of inquiry has involved a broad class of univarate point processes known as semi-Markov generated point processes. A semi-Markov generated point process may be thought of as a superposition of dependent renewal processes. The spectral and distributional characteristics are developed for such processes with finite state space, and the superposition of renewal processes with Erlang or hyperexponential interval distributions is shown to have an equivalent representation as a semi-Markov generated point process. Equivalence here refers to the probabilistic structure of the time between events, and more specifically, the spectral properties.

AD-A010 578/3CP PC **A02**/MF **A01**
Carnegie-Mellon Univ Pittsburgh Pa
On Fourier's Analysis of Linear Inequality Systems
R. J. Duffin. 23 Aug 73, 25p ARO-9300.16-M
Grant DA-ARO-D-31-124-71-G17
Availability: Pub. in Mathematical Programming Study 1, p71-95 1974.

Descriptors: *Linear programming, *Fourier analysis, Inequalities, Algorithms, Mathematical programming, Computer programs, Coding, Reprints.

Fourier treated a system of linear inequalities by a method of elimination of variables. This method can be used to derive the duality theory of linear programming. Perhaps this furnishes the quickest proof both for finite and infinite linear programs. For numerical evaluation of a linear program, Fourier's procedure is very cumbersome because a variable is eliminated by adding each pair of inequalities having coefficients of opposite sign. This introduces many redundant inequalities. However, modifications are possible which reduce the number of redundant inequalities generated. With these modifications the methods of Fourier becomes a practical computational algorithm for a class of pararnetric linear programs. (Author)

AD-A010 733/4CP PC **A03**/MF **A01**
Air Force Inst of Tech Wright-Patterson AFB Ohio
Quadratic Programming Using Generalized Inverses
Final rept. Jan 74-May 75
Donn G. Shankland. May 75, 45p Rept no. AFIT-TR-75-2

Descriptors: *Quadratic programming, Inequalities, Matrices(Mathematics), Nonlinear programming, Lagrangian functions, Algorithms, Computer programs.
Identifiers: Inverse problems, Lagrange multipliers.

A method is presented for computing the optimum value of a quadratic functional subject to linear inequalities, which rapidly ascertains which, if any, of the inequalities are binding at the optimum point. The method resembles that of H. Theil and C. Van de Panne, but no combinatorial analysis needs be performed to isolate the binding constraints. All violated constraints are imposed as equalities, and those with positive Lagrangian multipliers are retained. Contradictory equalities are automatically resolved by the use of the generalized inverse. The method appears most useful in systems with large numbers of variables and constraints.

AD-A011 030/4CP Not available NTIS
Rand Computation Center Santa Monica Calif
A RAND Computation Center Reference: A Root-Finding Program for JOSS
J. E. Ballinger. Oct 74, 11p Rept no. R-1550/9
Availability: Paper copy available from RAND Corporation, 1700 Main Street, Santa Monica, Calif. 90406, PC$1.50.

Descriptors: *Polynomials, *Computer programs, Complex variables, Approximation(Mathematics), Numerical analysis.
Identifiers: *Roots of equations, JOSS computer systems.

The purpose of this document is to present a JOSS program that will find all roots, real and complex, of an nth degree polynomial with real coefficients.

AD-A011 039/5CP PC **A03**/MF **A01**
Naval Ship Research and Development Center Bethesda Md
CSKYDG2: An Out-of-Core Choleksy Algorithm Equation Solver (With Respect to Profile) for Large Positive Definite Systems of Linear Equations
Donald A. Gignac. Mar 75, 37p Rept no. NSRDC-4655

Descriptors: *Matrices(Mathematics), *Computer programs, Linear algebraic equations, Numerical analysis, FORTRAN, Structural properties.
Identifiers: CSKYDG2 computer program, Cholesky algorithm, CDC 6600 computers.

In the finite element approach to static structural analysis the solution of the equation KU = P is basic. However, the order of K is often so large that, even when the symmetry and banded structure of K are taken into account the storage of K in the core memory of a computer may not be feasible or even possible. To handle such a case, the computer program CSKYDG2 has been developed. CSKYDG2 is an out-of-core Cholesky algorithm solver for positive definite systems of simultaneous linear equations. CSKYDG2, which takes the profile approach, uses SETUP, a preprocessor program which stores the profile of the upper triangular half of the matrix K in random access files. CSKYDG2 and SETUP are written in FORTRAN Extended for the CDC 6000 series of computers.

AD-A011 107/0CP PC **A04**/MF **A01**
Harvard Univ Cambridge Mass Aiken Computation Lab
FORTRAN Implementations of Marching Algorithms
Technical rept. Sep 74-May 75
Randolph E. Bank. 27 May 75, 72p Rept no. TR-17-75
Contract N00014-75-C-0243

Descriptors: *Boundary value problems, *Partial differential equations, *Computer programs, Matrices(Mathematics), Finite difference theory, Numerical integration, Computations, Algorithms, FORTRAN.
Identifiers: *Marching algorithms, *Elliptic differential equations.

FORTRAN implementations are given for several marching algorithms for solving the block tridiagonal linear systems which arise from standard 5-point difference approximations to elliptic boundary value problems in two dimensions.

AD-A011 583/2CP PC **A05**/MF **A01**
George Washington Univ Washington D C Graduate School of Arts and Sciences
Methods of Fitting Learning Curves to Lot Data Based on Assumptions and Techniques of Regression Analysis
Master's thesis
Robert Blair Ilderton. Aug 70, 89p

Descriptors: *Learning curves, *Regression analysis, Curve fitting, Least squares method, Computer programming, Cost estimates, Computations, Theses.
Identifiers: ICLOT computer program, CALOT computer program.

This thesis is primarily concerned with the formulae and mathematical procedures incorporated in the ICLOT and CALOT programs which were developed in 1967 to fit learning curves to historical lot data under the unit curve and cumulative average curve theories, respectively. The same formulae and procedures were also incorporated in the ICUNI and CAUNI programs, which were developed at the same time to fit learning curves to unit data. These programs have been used to support DCAA recommendations on cost estimates submitted by hundreds of defense contractors. This usage, plus the availability of these programs in the general libraries of services which account for most of the time-shared computer usage in the United States, has led to their adoption by many defense contractors and other time-shared computer customers.

AD-A011 769/7CP PC **A05**/MF **A01**
Lockheed Missiles and Space Co Inc Sunnyvale Calif
Problem Controlled Grid Generation for the Numerical Solution of Partial Differential Equations
Paul S. Jensen, Francis A. Brogan, and Carlos A. Felippa. 27 May 75, 81p LMSC-D469784, AFOSR-TR-75-0811
Contract F44620-71-C-0109

Descriptors: *Partial differential equations, *Numerical integration, *Computer programming, Finite difference theory, Finite element analysis, Approximation, Eigenvectors, Algorithms, Boundary value problems.
Identifiers: STAGS computer program, FIDAG computer program, *Elliptic differential equations.

Conventional finite element analysis of elliptic partial differential equations involves the establishment of a discretization grid on which an energy functional is defined and minimized. By including the positions of the grid nodes as unknowns in the energy functional, one can obtain the optimum placement of the nodes as well as the equation solution from the energy minimization. The potential of Chebyshev iterate acceleration in the inverse iteration eigensolution process has long been understood but not realized in practical applications. Its potential is readily realized in the sectioning algorithm by virtue of the fixed interval over which analysis is made.

AD-A012 100/4CP PC **A03**/MF **A01**
George Washington Univ Washington D C Inst for Management Science and Engineering
Maximum Likelihood Estimation of the Parameters of a Power Rule Model Using the Sequential Unconstrained Minimization Technique (SUMT)
Technical memo. 1 Jan-31 Mar 75
Faiz A. Al-Khayyal. 31 Mar 75, 26p TM-64852, ARL-75-0217

Descriptors: *Nonlinear programming, Statistical analysis, Computer programs, Optimization, Accelerated testing, Life tests.
Identifiers: *Sequential unconstrained minimization technique, Maximum likelihood estimation, Parameter estimation, Factorable programming, SUMT computer program.

In this memorandum the author deals with an application of a modified procedure for SUMT to a maximum likelihood estimation problem which arises in the study by SINGPURWALLA (1975) on accelerated life tests. After a short background to this modification, the author defines what is meant by a factorable programming problem. A simple example of how to rewrite a nonlinear equation into factorable form is given, followed by a detailed restatement of maximizing the likelihood function as a factorable programming problem. The procedure is outlined for using the factorable programming interface with SUMT and illustrate its use is illustrated.

AD-A012 624/3CP PC **E02**/MF **A01**
Naval Postgraduate School Monterey Calif
An Alternating Direction Galerkin Method for Nonlinear Parabolic Problems
Master's thesis
John Mark Franklin. Jun 75, 76

Descriptors: *Partial differential equations, *Nonlinear differential equations, *Approximation, Laplace transformation, Hilbert space, Numerical integration, Theses, Computer programs, FORTRAN.
Identifiers: *Parabolic differential equations, *Galerkin method, Bicubic splines, IBM 360/67 computers, FORTRAN 4 programming language, Heat equation.

An implementation of the Laplace modified centered difference Galerkin method for the solution of the general non-linear parabolic differential equation is given. Alternating directions methods are used to approximate the solution in two dimensions for a rectangle. Hermite cubics are used as basis functions for the space.

AD-A012 828/0CP PC **E02**/MF **A01**
Stanford Univ Calif Dept of Statistics
On Testing and Estimating the Interaction Between Treatments and Environmental Conditions in Binomial Experiments, I: The Case of Two Stations
Technical rept.
S. Zacks, and H. Solomon. 2 May 75, 41 Rept no. TR-220
Contract N00014-67-A-0112-0085
Sponsored in part by Army Research Office, Durham, N.C., and Air Force Office of Scientific Research, Arlington, Va.

Descriptors: *Sampling, *Confidence limits, Approximation, Distribution functions, Computer programs, FORTRAN, Computations, Risk.
Identifiers: Contingency tables, Maximum likelihood estimation.

Estimating confidence intervals for the interaction between treatments and environmental conditions in binomial experiments is analyzed. Testing the interaction is studied also. The problem is reduced to that of estimating or testing the interaction parameter in 2x2x2 contingency tables with given marginals. Programs for determining the exact conditional tests and their power functions are provided for samples of size not exceeding 100. Large sample approximations based on maximum likelihood (ML) and on the arcsin transformation for proportions are studied. It is shown that the arcsin transformation is effective also in small samples and may yield asymmetric confidence intervals which are shorter than exact conditional confidence limits.

AD-A012 996/5CP PC **A04**/MF **A01**
Stanford Univ Calif Systems Optimization Lab
A Mini-Manual for Use of the SUMT Computer Program and the Factorable Programming Language
Technical rept.
Garth P. McCormick. Aug 74, 55p Rept no. SOL-74-15
Contract N00014-67-A-0112-0011, AT(04-3)-326
Sponsored in part by Grants NSF-GP-31393, and NSF-GJ-30408.

Descriptors: *Nonlinear programming, *Computer programs, FORTRAN, Instruction manuals, Computations.
Identifiers: *SUMT computer program.

This manual contains a shortened version of the usage of the SUMT computer program when user supplied subroutines are required. It also explains how a new nonlinear programming language (factorable programming) can be used to input the problem functions. Using this mode, all function derivatives and hessian matrices are automatically computed. The third part of the manual explains how to use the new language independently of the SUMT program.

AD-A013 095/5CP PC **A02**/MF **A01**
Union Coll Schenectady N Y Inst of Administration and Management
Exact Sequential Tests for the Variance
Final rept. 1-31 Jan 75
Leo A. Aroian, X. G. Gorge, T. I. Goss, and D. E. Robison. 31 Jan 75, 21p Rept no. AES-7501
Contract N00014-72-A-0507-0001

Descriptors: *Statistical tests, *Sequential analysis, *Standard deviation, *Normal distribution, Truncation, Sampling, Analysis of variance, Mean, Probability, Maintainability, Life tests, Computer programs.
Identifiers: *Direct method(Mathematics), Wald theory, Truncated sequential tests, Chi-square tests, Operating characteristic functions.

Exact sequential tests for the unknown variance when sampling from a normal distribution with mean and variance of standard deviation are derived whether the mean is known or unknown. While Wald regions are used, the methods are perfectly general either for truncated or untruncated regions. The operating characteristic function, the average sample number, and the distribution of the decisive sample number are obtained by use of the direct method. (Author)

AD-A013 150/8CP PC **A02**/MF **A01**
Northwestern Univ Evanston Ill Dept of Industrial Engineering and Management Sciences
Projections of Convex Programs with Unattained Infima
Robert A. Abrams. 5 Jul 73, 15p AFOSR-TR-75-1029
Grant AF-AFOSR-2516-73
Availability: Pub. in SIAM Jnl. of Control, v13 n3 p706-718 May 75.

Descriptors: *Convex sets, *Quadratic programming, *Set theory, Topology, Groups(Mathematics), Complex variables, Transformations, Reprints.
Identifiers: *Convex programming, Degeneracy, Nondegenerate computer programs, Unattained infirma, Unbounded solution set, Posynomiac geometric programming, Constraints.

Convex programs with closed objective function and closed feasible region are classified as degenerate if the objective function and the feasible region have a common direction of recession. For each degenerate program, a reduced form is defined by projecting the feasible region and the objective function epigraph on the orthogonal complement of the recession directions. A finite sequence of such reductions yields a nondegenerate problem for which the infimum is attained on a bounded set. Under a very mild condition the infimum of the reduced problem is equal to that of the

original problem. It is shown that the objective and constraint functions of the 'projected' problem may be obtained by calculating limits of the objective and constraint functions in the directions of recession. These results generalize the concept of degeneracy and reduction to canonical form which was originally developed for posynomial geometric programming. (Author)

AD-A013 175/5CP PC **A03**/MF **A01**
George Washington Univ Washington D C Program in Logistics
Adaptive Forecasting of the Size of a Force Subject to Random Withdrawals
S. Zacks. 9 May 75, 33p Rept no. Serial-T-315
Contract N00014-75-C-0729
Report on Phase 2 forecasting.

Descriptors: *Logistics planning, *Forecasting, *Marine corps, *Force level, Bayes theorem, Mathematical prediction, Estimates, Probability density functions, Regression analysis, Computer programs, FORTRAN.

Adaptive forecasting procedures are developed for a problem of predicting the size of a force which is subject to random withdrawals. The structure of the problem is phrased in terms of the Marine Corps. The author distinguishes between four phases in the service of incoming cohorts. Methods of forecasting have been developed for each phase separately. The present study concentrates on Phase 2 forecasting. The author compares three forecasting procedures: conditional maximum likelihood estimation of prediction intervals; tolerance intervals, and Bayes prediction intervals. The theory of these forecasting procedures is developed and numerical examples illustrate it.

AD-A013 190/4CP PC **A03**/MF **A01**
Environmental Prediction Research Facility (Navy) Monterey Calif
Subroutines for Direct Solution of Two-Dimensional Elliptic Equations
Computer programming note
Thomas E. Rosmond. Apr 75, 33p Rept no. EPRF-CP Note-23

Descriptors: *Partial differential equations, *Computer programs, *Numerical analysis, *Numerical integration, Subroutines, Computations, Finite difference theory.
Identifiers: *Elliptic differential equations, POISNT subroutine, POISDT subroutine, POITRG subroutine, POISPT subroutine, Poisson equation, Helmholtz equation.

The report contains the documentation of four subroutines for the direct numerical solution of separable elliptic partial differential equations. The routines use the block-cyclic reduction and factoralization algorithm described by Buzbee, Golub, and Nielson (1970), Sweet (1973), and Rosmond and Faulkner (1975). The subroutines are modifications of programs developed by Dr. Roland Sweet of NCAR. The four subroutines are called POISDT, POISPT, POISNT, and POITRG. They solve two-dimensional Poisson's or Helmholtz's equations with, in the y-coordinate direction, Dirichlet B.C., periodic B.C., Neumann B.C. on an unstaggered grid, or Neumann B.C. on a staggered grid, respectively.

AD-A013 191/2CP PC **A03**/MF **A01**
Environmental Prediction Research Facility (Navy) Monterey Calif
Subroutines for Direct Solution of Three-Dimensional Elliptic Equations
Computer programming note
Thomas E. Rosmond. Mar 75, 41p Rept no. EPRF-CP-Note-22

Descriptors: *Partial differential equations, *Computer programs, *Numerical integration, Subroutines, Computations.
Identifiers: *Elliptic differential equations, POI3DD subroutine, POI3NN subroutine, POI3PP subroutine.

This report documents three subroutines for the direct numerical solution of three-dimensional separable elliptic equations. The Buneman method of cyclic reduction and factoralization is applied to first reduce a three-dimensional matrix equation to a series of two-dimensional Helmholtz equations. These two-dimensional equations are then reduced by the same method to a series of one-dimensional tridiagonal systems which can be solved very quickly by Gaussian elimination. Three routines are described :POI3DD, POI3NN, and POI3PP. POI3DD assumes Dirichlet conditions on at least two sets of opposite faces of a rectangular body. POI3NN assumes Neumann condition on a staggered grid on at least two sets of faces. POI3PP assumes periodic conditions on at least 2 sets of faces. On the third set of faces any non-periodic conditions can be prescribed. In addition the routines are written in modular form so that other combinations of boundary conditions are easily adopted.

AD-A013 240/7CP PC **A08**/MF **A01**
Union Coll Schenectady N Y Inst of Administration and Management
Sequential Tests of the Hypergeometric Distribution
Final rept. 1 Jan-31 Dec 75
William Q. Meeker, Jr. 31 May 75, 154p Rept no. AES-7506
Contract N00014-75-C-0583-0002
See also AD-A013 241.

Descriptors: *Statistical tests, *Sequential analysis, Sampling, Distribution functions, Computations, Computer programs, Theses.
Identifiers: *Wald sequential test, *Hypergeometric density functions.

Wald's theory is used to find truncated sequential test regions for the hypergeometric distribution. These regions are then evaluated using Aroian's direct method of sequential analysis. Using this method, the important test properties (operating characteristic (OC) function, average sample number (ASN) function and the distribution of the decisive sample number (DSN)) are found exactly. The tests are compared with other similar tests (both sequential and fixed size) and estimation of the parameter after completion of the sequential test is treated. Numerical examples and general computer programs are also included.

AD-A013 241/5CP PC **A09**/MF **A01**
Union Coll Schenectady N Y Inst of Administration and Management
Sequential Tests for 2x2 Contingency Tables
Final rept. 1 Jan-31 Dec 75
William Q. Meeker, Jr. 31 May 75, 183p Rept no. AES-7507
Contract N00014-75-C-0583-0002
See AD-A013 240.

Descriptors: *Statistical tests, *Sequential analysis, Probability density functions, Hypotheses, Sampling, Computations, Tables(Data), Computer programs, Theses.
Identifiers: *Contingency tables.

This report deals with sequential tests of problems which can be formulated in terms of a 2x2 contingency table. All of the important cases (marginal probabilities known and unknown and marginal populations 'observable' and 'not observable') are treated. Theory for finding the sequential test regions is developed and the exact values of the important test properties are found using Aroian's direct method of sequential analysis. The tests are compared with fixed size tests and a method of estimation is presented. Numerical examples and computer programs are included.

AD-A013 418/9CP PC **A08**/MF **A01**
Toledo Univ Ohio Dept of Mathematics
Conjugate Direction Algorithms in Numerical Analysis and Optimization
Final rept. 31 Aug 73-31 Jan 75
Junior Stein. Jun 75, 152p ARO-11856.1-M
Grant DAHC04-74-G-0006, NSF-GP-40175

Descriptors: *Algorithms, *Numerical analysis, Optimization, Computer programs, Fortran, Functions, Mathematical models.

The purpose of this paper is to present some effective optimization techniques in numerical analysis. A mathematical development and a geometric interpretation of the conjugate direction method are presented. The method is used to minimize a real valued function of n real variables. Included are numerical computations for a variety of test functions. The results are compared computationally with other methods used in minimization. Also, listings of computer programs are included. (Author)

AD-A013 466/8CP PC **A06**/MF **A01**
Naval Postgraduate School Monterey Calif
Models for Multi-Item Inventory Systems with Constraints
Doctoral thesis
William Edward Daeschner, Jr. Jun 75, 119p

Descriptors: *Inventory control, Stochastic processes, Integer programming, Allocations, Computer programs, Budgets, Theses, FORTRAN.
Identifiers: Demand(Economics), Lagrange multipliers, Bad buys.

Constrained multi-item inventory systems with stochastic demands are addressed. The concept of Bad Buys is introduced and their temporal development is studied through a model which links the financial and line-item inventory control subsystems. The interaction of budget constraints and control policies having stochastic resource requirement are examined using a queueing model. Some line-item control systems in current use are shown to be incompatible with budget constrained financial control mechanisms. A model and solution procedure are furnished to guide the line-item inventory control subsystem in exercising adaptive control of a multi-item inventory with stochastic demands and fixed resources provided in successive fiscal periods. An interactive FORTRAN computer program is furnished which exploits the Generalized Lagrange Multiplier procedure in obtaining optimal or near-optimal integer solutions to a class of non-linear integer programming problems.

AD-A013 683/8CP PC **A07**/MF **A01**
Aerospace Research Labs Wright-Patterson AFB Ohio
A Topological Analysis Research and Demonstration Computer Program Library
Final rept. 1 Aug 72-1 Aug 74
Kenneth O. Leland. Jun 75, 141p Rept no. ARL-75-0155

Descriptors: *Topology, *Computer programming, Mapping(Transformations), Complex numbers, Logarithm functions, Computations, Subroutines, FORTRAN.

This report describes a computer program designed to operate in either batch mode or interactive conversational mode, created for the purposes of demonstrating certain aspects of the foundations of complex function theory and of facilitating research therein. The program is built around the concept of winding number which it relates to the concept of integer valued analogue of the complex analytic logarithm function. This number counts the number of times a closed path in the plane 'winds' about a point. It can be expressed in terms of concepts of combinatorial topology or analytically in terms of complex contour integrals or complex logarithm functions. A detailed set of instructions on how to use the program as well as a listing of the program coding is included.

AD-A014 014/5CP PC **A02**/MF **A01**
Lockheed Missiles and Space Co Inc Palo Alto Calif Palo Alto Research Lab
Solution of Two-Dimensional Boundary Value Problems by Arbitrary Grid Finite Difference Methods
Paul S. Jensen. 1974, 6p AFOSR-TR-75-1165
Contract F44620-71-C-0109
Availability: Pub. in AICA, p80-85 1975.

Descriptors: *Finite difference theory, *Numerical analysis, *Partial differential equations, *Boundary value problems, Set theory, Ellipses, Grids, Com-

puter applications, Flat plate models, Computer programs, Reprints.

There are a variety of numerical methods in current use for solving elliptic partial differential equations on modern computers. Classification of these methods in terms of the forms of node sets N and meshes M used is discussed. A class N method, which involves the node set only is studied. This involves the construction of finite difference expressions on an arbitrary node set (grid)which is subject to the fundamental finite differencing problem of neighbor selection called the 'bad neighbor problem.' An effective solution to this problem is presented. Numerical results for a plate problem are presented and compared with results from other analysis programs.

AD-A014 076/4CP PC **A04**/MF **A01**
Naval Research Lab Washington D C
A Fortran Program for Rapid Computations Involving the Non-Central, Chi-Square Distribution
Final rept.
Howard L. Wiener. Aug 75, 60p Rept no. NRL-MR-3106

Descriptors: *Statistical tests, *Computer programs, Computations, FORTRAN, Degrees of freedom, Ocean surveillance.
Identifiers: Chi square density functions, CDC 3600 computers, LAMBDA computer program, NOVA 800 computers, Chi square test.

A computer program has been developed for rapidly computing the non-centrality parameter in a statistical test of the chi-square distribution against a non-central chi-square alternative, when the number of degrees of freedom, the level of significance, and the power are all specified. The program produces results similar to those in previously published tables but operates with a marked saving in execution time. The program is well suited to implementation as part of a larger program, as part of a man-computer interactive system, or within a minicomputer. The report contains a program listing together with tables of computed values of the noncentrality.

AD-A014 197/8CP PC **A03**/MF **A01**
Army Missile Research Development and Engineering Lab Redstone Arsenal Ala Advanced Sensors Directorate
A FORTRAN Program for the Calculation of the State Transition Matrix as a Linear Combination of Real Time Functions (EAT)
Technical rept.
Lewis G. Minor, and John R. Underwood. 16 May 75, 46p Rept no. RE-75-32

Descriptors: *Matrices(Mathematics), *Computer programs, *Differential equations, *FORTRAN, Linear systems, Real time, Functions(Mathematics), Numerical analysis, Eigenvectors.
Identifiers: *State transition matrix, *Real time functions.

Many programs are available which calculate numerically the state transition matrix at a specific time. However, programs which give the solution as a linear combination of real time functions are not generally available. The program given in this report calculates the state transition matrix as a linear combination of real time functions starting from any real system matrix. (Author)

AD-A014 214/1CP PC **A02**/MF **A01**
Pennsylvania State Univ University Park Applied Research Lab
Accurate Fourier Analysis of Arbitrary Functions Defined by Discrete Data Values
Technical memo.
M. W. McBride. 26 Mar 75, 24p Rept no. TM-75-78
Contract N00017-73-C-1418

Descriptors: *Fourier analysis, *Computer applications, Integral equations, Numerical integration, Taylors series, Computations, Computer programs.
Identifiers: Spline interpolation.

A computerized analysis has been developed to determine the Fourier coefficients of arbitrary functions defined by discrete point values. The method described in this report is more accurate than the trapezoidal integration technique commonly used. Basically, the technique is a summation of exact integrals defined in small regions by a Taylor Series expansion of the data. Derivatives necessary for the expansion are determined by a parametric spline curve function, fitting the original data. The parametric spline is described briefly. Examples of the use and accuracy of a coefficient computation program are presented. The described method is shown to have twice the accuracy of the previous method for equal computation times. The ultimate accuracy of the method is shown to be an order of magnitude better than that of the older method.

AD-A014 822/1CP PC **A08**/MF **A01**
Aerospace Corp El Segundo Calif Engineering Science Operations
The Eclectic Simulator Program (ESP) Usage Guide
Interim rept. 1 Jul 68-30 Jun 75
Emmagene R. Coffey, and Harvey J. Wertz. 30 Jun 75, 172p TR-0075(9320)-5, SAMSO-TR-75-201
Contract F04701-74-C-0075
Revision of Rept. no. TOR-0200(4307-02)-1 dated Jul 68, AD-840 095.

Descriptors: *Programming languages, *Differential equations, *Mathematical programming, *Computer programs, *Compilers, *Computerized simulation, Computer programming, FORTRAN, Problem solving, Numerical integration, Integration, Subroutines, Matrices(Mathematics), Instruction manuals.
Identifiers: ESP(Eclectic simulation program), Eclectic simulation program, Discontinuous driving functions, Precompilers.

The Eclectic Simulator Program (ESP) is a system (a precompiler plus a collection of subroutines) that permits the fast, easy solution of ordinary differential equations. Any user with a general knowledge of FORTRAN can utilize ESP's many labor-saving devices to code a problem with minimal effort. Special ESP features permit translation of engineering blocks, discontinuities, and hysteresis patterns directly into computer code, and the use of WHELP in conjunction with ESP facilitates efficient coding of matrix algebra equations. Simple input cards enable the user to directly control solution and timing accuracy and to specify or change run times, initial conditions, and various other parameters easily when making multiple or stacked runs. Finally, ESP allows the user to select from a wide variety of output options. This manual is intended to be both a learning tool for the novice and a detailed reference for the experienced user. (Author)

AD-A014 853/6CP PC **A03**/MF **A01**
California Univ Berkeley Electronics Research Lab
A Program to Compute the Condition Numbers of Matrix Eigenvalues without Computing Eigenvectors
Final rept.
S. P. Chan, R. Feldman, and B. N. Parlett. Apr 75, 50p Rept no. ERL-M517
Contract N00014-69-A-0200-1017

Descriptors: *Matrices(Mathematics), *Computer programs, Eigenvectors, Computations, Algorithms, FORTRAN.
Identifiers: *Eigenvalues.

The condition number of an eigenvalue measures the sensitivity of that eigenvalue to small changes in the matrix elements. Such extra information is nice, sometimes useful, but how much does it cost. A program is presented here for the most difficult case of a real square matrix whose eigenvalues are wanted without their corresponding eigenvectors. The program requires no extra storage space and the running time is about 50% longer than for the fastest reliable program which only computes eigenvalues. There are many industrial applications in which the matrix elements are known to only two or three decimal figures. Each condition number will indicate how accurately such a matrix determines the associated eigenvalue. When no digits in an eigenvalue are reliable the suspect eigenvalue should be tagged and this information passed on to a higher level in the whole computation. A number of programming devices keep the code, storage, and running time down to a minimum. An interesting case study is included.

AD-A014 854/4CP PC **A03**/MF **A01**
California Univ Berkeley Electronics Research Lab
A Program to Compute the Real Schur Form of a Real Square Matrix
Final rept.
B. N. Parlett, and R. Feldman. Jun 75, 32p Rept no. ERL-M526
Contract N00014-69-A-0200-1017

Descriptors: *Matrices(Mathematics), *Computer programs, Computations, Permutations, Algorithms, FORTRAN.
Identifiers: Schur functions, Canonical forms.

A FORTRAN program is presented which will obtain the real Schur form of a real nxn matrix in 10(n sup 3) + 30(N sup 2) multiplications (approximately).

AD-A014 949/2CP PC **A02**/MF **A01**
New Mexico State Univ University Park Engineering Experiment Station
Recursive and Moving Cubic Spline Interpolation Methods
Final rept. (Part 2), 14 Jan 74-13 Jan 75
Lonnie C. Ludeman. 1 Mar 75, 12p ARO-11422.3-A
Grant DAHC04-74-G-0084
See also AD-A014 948.

Descriptors: *Polynomials, *Recursive functions, *Algorithms, *Approximation(Mathematics), *Set theory, Interpolation, Computer programs, Differential equations.
Identifiers: Cubic splines, Spline functions.

This report presents the analysis for algorithms to compute the recursive and moving spline approximations passing through a given set of values for uniformly spaced absicissa. A computer program for the recursive calculation is also given. (Author)

AD-A015 788/3CP PC **A03**/MF **A01**
Michigan State Univ East Lansing Dept of Mathematics
Uniform Rational Approximation of Functions of Several Variables
E. H. Kaufman, Jr, and G. D. Taylor. 14 Dec 73, 28p AFOSR-TR-75-1456
Grant AF-AFOSR-2271-72
Availability: Pub. in International Jnl. for Numerical Methods in Engineering, v9 p297-323 1975.

Descriptors: *Rational functions, *Approximation(Mathematics), *Complex variables, Computer programs, FORTRAN, Algorithms, Linear programming, Differential equations, Reprints.
Identifiers: Uniform fit.

This paper gives a description and Fortran listing of a program that gives a uniform fit to a given finite data set by polynomials rational functions generalized polynomials or generalized rational functions. This method used is a linear programming approach known as the differential correction algorithm and has given excellent results in many test cases. (Author)

AD-A016 188/5CP PC **A12**/MF **A01**
Stanford Univ Calif Systems Optimization Lab
Parametric Techniques for Multistage Stochastic Allocation
Technical rept.
Robert E. Doherty. Aug 75, 258p Rept no. SOL-75-19
Contract N00014-75-C-0267, AT(04-3)-326

Descriptors: *Allocations, *Stochastic processes, *Mathematical programming, Decision making, Mathematical models, Computer programs, FORTRAN.

Identifiers: Utility theory, Resource allocation, FORTRAN 4 programming language.

This paper treats a problem of multistage allocation under conditions of risk. After qualitative features of the problem are discussed, an efficiency procedure is formulated and is shown to have desirable computational, utility-theoretic, and asymptotic properties. Several techniques are then developed which are applicable to an approximation of the efficient frontier by parametric complementary pivoting. These include a parametric algorithm for a minimax approximation, some parametric decomposition methods, and an interactive algorithm for certain problems with a block-angular structure. A listing for a Fortran 4 code solving the parametric linear complementarity problem is given in an appendix.

AD-A016 906/0CP PC **A04**/MF **A01**
Ballistic Research Labs Aberdeen Proving Ground Md
Application of Marquardt's Nonlinear Least Squares Algorithm to Free-Flight Yaw Data Analysis
Final memorandum rept.
James W. Bradley. Sep 75, 54p Rept no. BRL-MR-2526

Descriptors: *Free flight, *Curve fitting, *Computer applications, *Yaw, Partial differential equations, Approximation, Analytic functions, Computer programs, Least squares method, Steepest descent method, FORTRAN.
Identifiers: *Marquardt algorithm.

Marquardt's algorithm is an imporved technique for the least squares estimation of nonlinear parameters. The present report describes the algorithm and documents a FORTRAN subroutine for carrying it out. A specific application of the subroutine is discussed in detail: fitting a complex yaw equation to data obtained from a Free Flight Range. An example is given in which the fitting process converged to the wrong answer without the algorithm and to the right answer with it.

AD-A017 116/5CP MF **A01**
Army Mobility Equipment Research and Development Center Fort Belvoir Va
Programming Language for the Solution of Partial Differential Equations Using Hybrid Computers. Phase I
Interim rept. Jul 73-Jul 74
J. Thomas Broach, and Robert M. III McKechnie. Mar 75, 83p Rept no. USAMERDC-2135
Availaibiity: Available in microfiche only.

Descriptors: *Hybrid computers, *Partial differential equations, *Computations, Numerical integration, Computer graphics, Data processing terminals, Programming languages, Computer programs.

The report covers the first phase of work intended to provide a hybrid-computer solution language for partial differential equations. The programming techniques and philosophy are discussed, and a sample problem solution is presented with details. This first attempt has been successful and provides a hybrid-computer scheme which is at least 50 times faster than the comparable purely digital approach. The program makes use of hybrid-computer graphics, with the input applied directly to the Tektronix 4010 Graphics Terminal and the solution curves presented to the graphics terminal on-line.

AD-A018 138/8CP PC **A03**/MF **A01**
Harvard Univ Cambridge Mass Aiken Computation Lab
A Recursive Analysis of Dissection Strategies
Technical rept. Jun 74-Oct 75
Donald J. Rose, and Gregory F. Whitten. Nov 75, 30p Rept no. TR-24-75
Contract N00014-75-C-0243

Descriptors: *Recursive functions, *Algorithms, *Algebraic functions, Numerical analysis, Computer programs, Fortran, Dissection, Computer graphics. Applied mathematics.
Identifiers: Partition functions.

A formalism for analyzing 'structurally recursive' (or 'divide and conquer') algorithms is developed, and give some examples of such algorithms in numerical algebra. In particular we analyze in detail nested dissection strategies for ordering sparse matrices arising from nxm grids in the plane. We then turn to issues of implementation and describe a software package for completely solving such sparse systems efficiently, paying particular attention to minimizing the list processing overhead. (Author)

AD-A018 171/9CP PC **A08**/MF **A01**
State Univ of New York At Buffalo Amherst Statistical Science Div
Comparison of Estimation Procedures for First Order Moving Average Multiple Time Series
Technical rept.
Berbardo Cass III Hamer. Aug 75, 151p Rept no. TR-32
Contract N00014-72-C-0508

Descriptors: *Time series analysis, Estimates, Fourier transformation, Multivariate analysis, Sampling, Spectrum analysis, Computer programs, Computations, Theses.
Identifiers: *Moving average, Parameter estimation, Maximum likelihood estimation, Fast Fourier transform.

This dissertation provides an empirical examination of four estimation procedures associated with the estimation of the matrix parameters for a vector moving average process. An important role in this examination is the development of the relationships between the parametric representation for both the vector autoregressive and moving average schemes. This leads to the examination, comparison and utilization of autoregressive order determination and fitting criteria. Spectral plotting and non-linear numerical techniques are also employed. A comparison of the estimation procedures is provided based upon both theoretical and practical criterion.

AD-A018 643/7CP PC **A05**/MF **A01**
Texas Univ At Austin Center for Numerical Analysis
Implementing Deferred Corrections for Numerov's Difference Method for Second-Order Two-Point Boundary-Value Problems
James W. Daniel, and Andrew J. Martin. Nov 75, 85p Rept no. CNA-107
Contract N00014-67-A-0126-0015

Descriptors: *Boundary value problems, *Finite difference theory, *Computer programming, Approximation, Computer programs, Computations, FORTRAN.
Identifiers: *Two point boundary value problems, CDC 6600 computers.

The iterated deferred correction of the standard fourth-order finite difference Numerov's method for second-order two-point boundary-value problems is implemented by an improved version of the codes developed by pereyra. The improvements are of a general nature so as to be applicable to the deferred correction of other basic schemes. While not polished enought to be called a production code, the computer code presented can be used as it stands by others or, preferably, can be used as the basis for the development of a production code suited to the needs and computer environment where it is implemented. Results of numerical experiments are described.

AD-A019 287/2CP PC **A05**/MF **A01**
Naval Postgraduate School Monterey Calif
Network Transformations and Some Applications
Master's thesis
Yue Pui Cheong. Dec 75, 82p

Descriptors: *Networks, *Economic models, *Commerce, *Computer programs, Transformations(Mathematics), Transportation, Theses, Programming languages.
Identifiers: Multicommodity flow problem, GNET solution code, Simplex programming language, GNET computer program.

The growing number of large scale applications of network models and the availability of very fast solution codes make it attractive to formulate problems as networks whenever such models are adequate for the purpose. In this thesis, conceptualization of, and notation used to express these models is based on the interpretation of physical flows of commodity through a network structure of nodes and arcs. As an aid to modelling, and to allow codes of varying specificity to be used, nine well-known Transformations are catalogued here for easy reference. Two recent results for special cases of the multicommodity flow problem are rederived and in the case of (1) below, is significantly extended: (1) The case with all capacitated arcs in the network structure incident with one common node. (2) The case of transportation structure with two sinks (or two sources). Using the network approach, these are shown to have equivalent network formulations. Lastly, a Transformation which uncapacitates a network is implemented in various ways into a contemporary solution code named GNET. (Author)

AD-A019 383/9CP PC **A08**/MF **A01**
Naval Postgraduate School Monterey Calif
Approximate Analytical Evaluation of Extended-Kalman Filters
Master's thesis
Hansan Oner Tasdelen. Dec 75, 175p

Descriptors: *Kalman filtering, Tracking, Computerized simulation, Monte Carlo method, Analytic functions, Computer programs, Theses.
Identifiers: Estimation theory, Parameter estimation.

Analytical equations derived for evaluating linear estimators are applied to extended-Kalman filters for approximate performance evaluation. Two cases were consdidred, a single known target trajectory and multiple target trajectories with given probabilities of occurrence. For the multiple-trajectory case, equations are derived for the mean and covariance of estimation error in terms of the conditional expectations. Two examples are presented to compare the use of the analytical equations with Monte-Carlo simulation.

AD-A019 532/1CP PC **A03**/MF **A01**
Michigan Univ Ann Arbor Systems Engineering Lab
Complexity of Vectorized Solution of Two-Dimensional Finite Element Grids
Technical interim rept.
D. A. Calahan. Nov 75, 37p SEL-TR-91, AFOSR-TR-75-1677
Grant AF-AFOSR-2812-75

Descriptors: *Finite element analysis, *Computations, Matrices(Mathematics), Algorithms, Computer programs.
Identifiers: *Vector computers, *Vector processing.

Given a two-dimensional grid of (2 sup n)-2 rectangular finite elements with m+2 nodes/side and l variables/node, a general dissection strategy is proposed for direct solution of the associated matrix equation. Expressions are developed in terms of m, n, and l for (1) the total number of multiplications and subtractions, and (2) a tight upper bound for the number of vector operations involved. The 'average vector length' L(ave) is defined as the ratio total operations/total vectors, and is shown useful as a gross measure of vectorization efficiency. The efficiency of current vector processors in solving dissected grids is evaluated using this measure.

AD-A019 796/2CP PC **A03**/MF **A01**
Institute for Defense Analyses Arlington Va Program Analysis Div
A Targeting Model That Minimizes Collateral Damage
Final rept.
Jeffrey J. Grotte. Dec 75, 32p P-1135, IDA/HQ-75-17630
Contract DAHC15-73-C-0200

Descriptors: *Strategic weapons, Allocations, Integer programming, Mathematical models, Computer programs, FORTRAN.
Identifiers: *Allocation models, Nonconvex programming.

This paper considers the problem of allocating weapons to achieve targeting objectives while simultaneously minimizing the aggregate damage to surrounding nonmilitary facilities, each of which has an upper limit to the damage it is permitted to incur. This problem is, in general, nonconvex. A model is formulated that assumes only that damage to individual targets or associated nonmilitary facilities does not decrease as the number of allocated weapons increases. An implicit enumeration algorithm, based on that of Lawler and Bell, is described that yields optimal integer solutions. An example is presented.

AD-A020 141/8CP PC **A06**/MF **A01**
Rand Corp Santa Monica Calif
CURVES: A Cost Analysis Curve-Fitting Program
Interim rept.
H. E. Boren, Jr, and G. W. Corwin. Dec 75, 103p Rept no. R-1753-PR
Contract F44620-73-C-0011

Descriptors: *Cost analysis, *Curve fitting, *Computer programs, Regression analysis, Least squares method, FORTRAN, Exponential functions, Learning curves, Cost estimates, Military equipment.
Identifiers: FORTRAN 4 programming language, Curves computer program, Logarithm functions.

The report describes a FORTRAN-4 curve-fitting computer program (CURVES) that makes least-squares determinations of the parameters of any of eight types of equations selected by the user, given a set of observations on the dependent and independent variables of interest. The types of equations that can be fitted are: linear, quadratic, power, asymptotic-power, exponential, logarithmic-linear, and two types of semilogarithmic-linear. Except for the quadratic and asymptotic-power equations, up to seven independent variables may be used. Y-intercepts may be specified for all equations except the power and exponential. A correlation matrix of the input data is provided for all fitted equations using more than one independent variable. Also included are standard errors and Student's t-ratios of the parameters, significance levels, beta coefficients, and the Durbin-Watson statistic. A plot routine is also incorporated. The program is fairly small (about 86,000 bytes of core), fast in execution time, and hence cheap to operate.

AD-A020 197/0CP PC **A04**/MF **A01**
Wisconsin Univ Madison Mathematics Research Center
INTE: A UNIVAC 1108/1110 Program for Numerical Integration with Rigorous Error Estimation
Technical summary rept.
Julia H. Gray, and L. B. Rall. Oct 75, 63p Rept no. MRC-TSR-1428
Contract DAAG29-75-C-0024, Grant NSF-GP-40381

Descriptors: *Integral equations, *Numerical integration, *Computer programs, Computations, Compilers, FORTRAN.
Identifiers: Interval analysis, UNIVAC 1108 computers, UNIVAC 1110 computers.

By use of the concepts of interval analysis, one can construct methods for numerical integration which give rigorous bounds on errors due to imprecise data, round-off, and truncation, and also make possible the detection of the use of incorrect formulas. On the basis of parameters obtained from interval integration formulas, the calculation of numerical integrals can be optimized with respect to time and accuracy. Improved error bounds can also be obtained in certain cases by intersection of interval results. This paper describes a computational system of interval type which has been implemented as a computer program for the UNIVAC 1108/1110, using software previously developed at MRC for interval analysis and automatic differentiation. The program accepts integrands which are functions of a single variable, written as one or more ordinary FORTRAN statements. In addition to the variable of integration, these statements may include one or more parameters to be specified by the user, and the program may be used in interactive or batch mode.

AD-A020 514/6CP PC **A11**/MF **A01**
Georgia Univ Athens Dept of Statistics and Computer Science
Computational Algorithms and Modules for the Evaluation of Statistical Distribution Functions
Technical rept.
Hubert Bouver , and Rolf E. Bargmann. Aug 75, 232p Rept nos. TR-110, THEMIS-UGA-36
Contract N00014-69-A-0423

Descriptors: *Computer applications, *Algorithms, *Statistics, Distribution functions, Statistical distributions, Computer programs, Power series.

This report presents a comparison of numerical methods for the evaluation of standard statistical distribution functions at with at least 10 significant digits of precision. Different series and continued fraction expansions were compared with the purpose of finding the most efficient techniques for different domains of the parameters of the Beta, Gamma, and normal distributions. Other techniques, including a Hermite expansion of exponents, a Wilson-Hilferty expansion, and asymptotic series of the Euler-McLaurin type were also investigated for extreme values of parameters. On the basis of time comparisons, the most efficient modules were combined into distribution packages. Further extensions to non-central distributions have been included in this package. (Author)

AD-A020 515/3CP PC **A13**/MF **A01**
Georgia Univ Athens Dept of Statistics and Computer Science
An Interactive Worksheet System for Statistical Usage
Technical rept.
Stephen F. Bingham, and Rolf E. Bargmann. Aug 75, 298p Rept nos. TR-106, THEMIS-UGA-31
Contract N00014-69-A-0423

Descriptors: *Interactive graphics, *Computer graphics, *Statistics, Computer programming, Data processing terminals, Multivariate analysis, Subroutines, Computer programs, Digital computers.
Identifiers: Conversational computation, Omnitab computer program, Worksheets, IBM 360 computers, IBM 370 computers.

This report discusses the implementation of an interactive version of the National Bureau of Standard's OMNITAB system. This version has been adopted to work under a Graphics Monitor System on an IBM 2250 terminal, connected to an IBM 360 or 370 central processor. Several routines have been added or adapted which make the system especially useful for statistical applications, and as an instructional tool. The immediate availability of displays of sections of the worksheet, after each instruction is the central feature of this adaptation. Several examples of statistical applications are included in this report. (Author)

AD-A020 734/0CP PC **A03**/MF **A01**
Michigan Univ Ann Arbor Dept of Electrical and Computer Engineering
A Sparsity-Oriented Approach to the Design of Mechanical Systems
Interim rept.
Nikki Orlandea, and Donald A. Calahan. 1975, 36p AFOSR-TR-76-0014
Grant AF-AFOSR-2812-75

Descriptors: *Mechanics, *Sparse matrix, *Computer aided design, Computer programs, Equations of motion, Three dimensional, Landing, Lagrangian functions, Functions(Mathematics), Velocity.
Identifiers: *Mechanical systems, Adams computer program.

In this paper, the systematic formulation of the equations of motion for three-dimensional mechanical systems (mechanisms) is considered in view of sparsity requirements for large simulation problems. Topological approaches of previous authors are extended to include the practical case of joint-constraints, and the resultant formulation is also related to Lagrange multiplier methods. Finally, a simulation example of a three-dimensional landing system model is studied several times larger than heretofore state-of-the-art problems and the growth rate of computation time with problem size is noted. (Author)

AD-A021 205/0CP PC **A04**/MF **A01**
Union Coll Schenectady N Y Inst of Administration and Management
Truncated Sequential Procedures for Complete Ranking of Several Binomial Populations
Final rept. 1 Jan-31 Dec 75
Ramesh Chandra. 31 Dec 75, 63p Rept no. AES-7513
Contract N00014-75-C-0583
Doctoral thesis.

Descriptors: *Sequential analysis, *Sampling, Decision theory, Computer programs, FORTRAN, Theses.
Identifiers: *Ranking, *Binomial density functions.

This study deals with the problem of complete ranking of k binomial populations. Developed are two truncated test procedures for handling two situations, namely (a) when the distance between populations is measured in terms of the odds ratio, (b) when it is measured in terms of difference (delta sub ij). Since no fixed sample size or truncated sequential procedure (in which the termination number is prespecified) exists for this purpose, a two-stage procedure is proposed.

AD-A021 224/1CP PC **A08**/MF **A01**
Analytic Services Inc Falls Church Va
Multidimensional Preferential Strategies
Strategic division note
John D. Matheson. Nov 75, 162p Rept no. ANSER-SDN-75-3
Contract F44620-76-C-0010

Descriptors: *Strategic warfare, *Game theory, Allocations, Weapon systems, Linear programming, Mathematical models.
Identifiers: *PATH method, PATH87 computer program, PATH87A computer program, Resource allocation.

This report presents a method of solving weapon allocation games involving many weapon types and many target types. Numerical solutions are obtained by the PATH method, a form of parametric linear programming. Two computer programs are listed and explained, PATH87 for two-sided games and the simpler PATH87A for one-sided optimizations. Both are copiously illustrated by sample runs. Other applications of the programs are discussed in general terms. The PATH method offers unique advantages of speed and flexibility in solving problems facing defense analysts, and it is hoped that publication of this report through the National Technical Information Service of the Defense Documentation Center will make this method more widely available. Also, the method has features which can be applied to many problems of resource allocation facing nondefense planners.

AD-A021 288/6CP PC **A05**/MF **A01**
Michigan Univ Ann Arbor Dept of Industrial and Operations Engineering
Two Finite Queues in Tandem with Pure Delay and Overflow
Technical rept.
Benedict Chung Wong. Jul 75, 91p Rept no. TR-75-7
Contract N00014-75-C-0492

Descriptors: *Queueing theory, Network flows, Computer programs, Matrices(Mathematics), Computations.
Identifiers: TANQ computer program.

Two single server queues with finite capacities are arranged in tandem. The arrival process to the first server is a Poisson stream with rate lambda. The

respective service times in the two servers are mutually independent, negative exponential distributed random variables, independent of the arrival process, with rates (Mu sub 1) and (Mu sub 2) respectively. The queue is assumed to be of first-come, first-served discipline. Both the pure delay (BCD) and the overflow (BCO) models are considered. The steady state solution is given.

AD-A021 668/9CP PC **A04**/MF **A01**
Maryland Univ College Park Computer Science Center
Further Programs for the Solution of Large Sparse Systems of Linear Equations
Technical rept.
Charles K. Mesztenyi, and Werner C. Rheinboldt. Aug 75, 51p Rept no. TR-394
Contract N00014-67-A-0239-0021, Grant NSF-GJ-35568

Descriptors: *Subroutines, *Computer programs, *Linear systems, *Matrices(Mathematics), Equations, Arrays, FORTRAN, Decomposition, Data storage systems.
Identifiers: *Linear equations, Data structure, Sparse matrix.

A package of FORTRAN subroutines is presented for the solution of non-symmetric or symmetric sparse linear systems by triangular decomposition. Two principle aims are (1) to handle matrices which originally fit into primary core storage but do so no longer after decomposition, and (2) to solve a sequence of linear systems all of which have the same sparsity structure by generating--in secondary storage--a record of the decomposition process in the form of an integer array. Some experimental results using the package are included. (Author)

AD-A021 915/4CP PC **A02**/MF **A01**
Naval Postgraduate School Monterey Calif
Epsilon - Optimality for a Global Optimization Algorithm
Technical rept.
James K. Hartman. Dec 75, 13p Rept no. NPS-55Hh75121

Descriptors: *Nonlinear programming, *Algorithms, *Complex variables, *Set theory, *Functions(Mathematics), Global, Optimization, Computer logic, Computer programs.
Identifiers: Global optimization, Nonconvex optimization.

The optimality conditions for a nonconvex global optimization algorithm are generalized to include epsilon - tolerances on the computations. The class of problems for which the new conditions imply epsilon - optimality is investigated and shown to be quite broad.

AD-A021 940/2CP PC **A02**/MF **A01**
Defense Communications Engineering Center Reston Va
A Unified Approach to Modelling Loop Service Systems: A Preliminary Report
Technical note
M. Fischer. Dec 75, 20p Rept no. TN-41-75

Descriptors: *Central processing units, *Communications networks, *Queueing theory, Mathematical models, Approximation, Analysis of variance.
Identifiers: M/G/1 queue.

Loop service systems are used as a model to predict the performance of such telecommunication systems as multidrop lines, concentrators and various satellites systems. Available results for different configurations are often based on different assumptions and so direct comparisons can not be made. This report presents a unified method of analyzing such congestion systems.

AD-A022 101/0CP PC **A09**/MF **A01**
Stanford Univ Calif Systems Optimization Lab
An Optimal Algorithm for the Resource Constrained Project Scheduling Problem
Technical rept.
Paul Franklin McCoy. Oct 75, 178p SOL-75-26, ARO-12215-9-M
Contract N00014-67-A-0112-0058, F44620-74-C-0079
Sponsored in part by Army Research Office, Research Triangle Park, N.C. Contract DAHC04-74-C-0034, Energy Research and Development Administration, Washington, D.C. Contract AT(04-3)-32€ and National Science Foundation, Washington, D.C. Grant NSF-GK-35491.

Descriptors: *Scheduling, Integer programming, Mathematical models, Network flows, Computer programs, Heuristic methods.
Identifiers: Constraints, *Project management, Resource allocation, Branch and bound method.

The report presents an algorithm for solving a form of the resource constrained project scheduling problem. This particular form of the problem differs from that usually considered in that the time needed to complete a job depends on the amount of resources applied to that job. Jobs are preemptable and the objective is to minimize the project duration. It is shown that this problem is equivalent to the problem of finding that transportation polytope, defined by the resource constraints, of minimal dimension which has a face specified by the precedence constraints. A theorem is presented which gives conditions under which a face of a specified type exists. Using this theorem, the problem transforms into an integer programming problem with variables representing the completion times for each job. The constraint set is defined by inequalities involving addition and maximum operations on the variables and, without the constraint that the variables be integer, the constraint set forms a nonconvex, polyhedral set.

AD-A023 134/0CP PC **A02**/MF **A01**
Colorado State Univ Fort Collins Dept of Mathematics
Evaluation of the Square Root Function on Microprocessors
Interim rept.
M. Andrews, S. F. McCormick, and G. D. Taylor. 1976, 23p AFOSR-TR-76-0379
Grant AF-AFOSR-2878-76, NSF-GJ-42626

Descriptors: *Microprocessors, *Square roots, *Microprogramming, *Computer programs, *Computer architecture, Algorithms, Numerical analysis, Digital computers, Polynomials, Iterations.
Identifiers: *Fixed point arithmetic, Newton method.

The software requirements for real time applications of microprocessors have received little attention from the scientific community. This reflects the need for the development of efficient algorithms to evaluate special functions for such purposes. The aim of this paper is to report on initial efforts to develop software for evaluation of the square root function in microprocessors utilizing fixed point computation. Numerical results of the performance of these algorithms are described for both eight and sixteen bit precision machines. (Author)

AD-A023 259/5CP PC **A06**/MF **A01**
Purdue Univ Lafayette Ind Dept of Statistics
The Effect of Change-Over Times on the M/G/1 Queue with Several Types of Customers
Interim rept.
Marcel F. Neuts. Jan 76, 112p Mimeograph Ser-441, AFOSR-TR-76-0156
Grant AF-AFOSR-2350-72

Descriptors: *Commerce, *Market research, *Markov processes, *Queueing theory, *Consumer problems, *Computer programs, Time, Probability, Consumers, Numerical analysis, Algorithms.
Identifiers: *Customers, Waiting time, M/G/1 queue, Customer change over.

An M/G/1 queue is studied with m types of customers, operating under the first-come, first-served discipline. It is assumed that the server expends a random length of time in change-over from one type of customer to another. Various priority rules have been proposed to reduce the amount of time spent in change-over. These queue disciplines generally require a separate monitoring, whose cost is frequently non-negligible. As a basis for evaluating the merits of alternate queue disciplines, it is important to have information on the M/G/1 queue with m customer types when service is first-come, first-served. By appealing to general methods for the M/SM/1 queue, a large number of detailed and explicit results are obtained. In addition, algorithmic solutions are given for the steady-state distributions which are analytically intractable. (Author)

AD-A023 863/4CP PC **A04**/MF **A01**
Mathematical Applications Group Inc Elmsford N Y
Eulerian Computations of Second Order Accuracy for Explosively Loaded Compressible Materials
Final rept.
Samuel Z. Burstein, Harold S. Schechter, and Eli L. Turkel. Sep 73, 52p Rept no. P-7037
Contract DAAA21-72-C-0431

Descriptors: *Explosives, *Detonation waves, *Equations of motion, Compressive properties, Finite difference theory, Partial differential equations, Numerical integration, Mathematical models, Computations, Nonlinear systems.
Identifiers: SMITE computer code.

Considering the complex interaction of nonlinear waves with a moving boundary it is necessary to use an accurate numerical approximation to the differential equations of motion in order to obtain a solution. In this paper the authors describe a method of solution for the problem based on an Eulerian formulation with moving boundaries. The scheme to be described in later sections has been incorporated in a code called SMITE (Second order Moving Interface Two dimensional Eulerian code).

AD-A023 932/7CP PC **A04**/MF **A01**
Army Concepts Analysis Agency Bethesda Md
A Computer Program for Fitting Progressively Censored Samples to a Normal or Lognormal Distribution (CENSNORM)
Documentation rept.
Richard A. Robinson. Mar 76, 60p Rept no. CAA-D-76-1

Descriptors: *Computer programs, *Statistical distributions, *Statistical samples, Chi square test, Fitting functions(Mathematics), Input output processing, Flow charting, Subroutines.
Identifiers: Maximum likelihood estimates, Lognormal distribution.

The CENSNORM is a UNIVAC 1108 computer program for fitting progressively censored samples to a normal or lognormal distribution. Maximum-likelihood estimating equations are used to calculate the distribution parameters. (Author)

AD-A024 144/8CP PC **A05**/MF **A01**
Georgia Inst of Tech Atlanta School of Industrial and Systems Engineering
An Application of Bayesian Analysis in Determining Appropriate Sample Sizes for Use in U.S. Army Operational Tests
Master's thesis
Robert L. Cordova. Jun 75, 76p
Contract DAAG39-75-C-0097

Descriptors: *Sampling, *Bayes theorem, *Reliability, Normal density functions, Analysis of variance, Degrees of freedom, Computer programs, FORTRAN.

The research is devoted to modifying the Bayesian techniques associated with determining the minimum sample size required to construct interval estimates of the true mean of an experimental or sampling process which is modeled by a normal distribution with unknown parameters. The procedure considers only the case where the prior information can be represented by a normal distribution with known mean and known variance.

AD-A024 197/6CP PC **A06**/MF **A01**
Georgia Inst of Tech Atlanta School of Industrial and Systems Engineering

A Comparison of the Applicability and Effectiveness of ANOVA with MANOVA for Use in the Operational Evaluation of Command and Control Systems
Master's thesis
Thomas Nelson Burnette, Jr. May 75, 116p
Contract DAAG39-75-C-0095

Descriptors: *Operational test and evaluation, *Command and control systems, *Analysis of variance, *Multivariate analysis, Army procurement, Mathematical models, Computer programs, FORTRAN, Theses.

This research addresses the problem of developing a usable methodology with which to compare the effectiveness of univariate analysis of variance (ANOVA) with multivariate analysis of variance (MANOVA), on the basis of powers of the tests, for use in comparative operational testing. The scope of the research was limited by considering only completely-crossed designs; two-factor, fixed-effects models; equal cell sample sizes; and no effect due to operators. In addition, it was assumed that an estimate of the multiresponse correlation matrix is available.

AD-A024 199/2CP PC **A06**/MF **A01**
Georgia Inst of Tech Atlanta School of Industrial and Systems Engineering
A Methodology to Establish the Criticality of Attributes in Operational Tests
Master's thesis
Gary Steven Williams. Oct 75, 111p
Contract DAAG39-75-C-0095

Descriptors: *Operational test and evaluation, *Army procurement, *Multivariate analysis, Mathematical models, Computer programs, Theses.

Operational testing is an integral part of the materiel acquisition cycle in the Army procurement process. It is oriented towards the evaluation of a developmental item under realistic conditions as part of an actual troop unit. The test design phase is an essential element of operational testing. In order to facilitate the selection of measures of effectiveness used in these tests, the critical attributes which 'best' discriminate between acceptable and unacceptable systems or subsystems need to be identified. This thesis addresses a method which provides a basis for the selection of these critical attributes. Once these attributes are identified, the test designers of subsequent operational tests may use this information to assist them in the test design phase.

AD-A024 204/0CP PC **A08**/MF **A01**
Georgia Inst of Tech Atlanta School of Industrial and Systems Engineering
An Application of Simulation Networking Techniques in Operational Test Design and Evaluation
Master's thesis
Elwyn LeRoy Brown. May 75, 171p
Contract DAAG39-75-C-0097

Descriptors: *Network analysis(Management), *Risk, Decision making, Procurement, Mathematical models, Computer programs, FORTRAN, Theses.
Identifiers: SOLVNET computer program, VERT computer program, FALCON computer program.

The purpose of this thesis may be summarized as follows: Review and analyze network simulation as a viable risk analysis technique for operational testing; Compare two existing computer programs available to conduct network simulation; Apply network simulation to an operational test design illustrating the criticality and sensitivity of test design data.

AD-A024 370/9CP PC **A02**/MF **A01**
Tel-Aviv Univ (Israel) Dept of Mathematical Sciences
A Note on the Leap-Frog Scheme in Two and Three Dimensions
Interim rept.
Saul Abarbanel, and David Gottlieb. Oct 75, 9p
75-21, AFOSR-TR-76-0480
Contract NAS1-14101, Grant AF-AFOSR-2370-72

Descriptors: *Finite difference theory, *Computer programs, *Numerical integration, *Hydrodynamics, Partial differential equations, Two dimensional, Three dimensional, Symmetry, Stability, Test methods, Modification.
Identifiers: Leap frog finite difference method, Hyperbolic equations, Hydrodynamic equations, Leap frog computer program.

It is shown how to improve the stability condition of the two and three dimensional Leap-Frog schemes by a simple modification of the original scheme. (Author)

AD-A024 384/0CP PC **A03**/MF **A01**
Naval Research Lab Washington D C
FORTRAN Subroutines to Evaluate, in Single or Double Precision, Bessel Functions of the First and Second Kinds for Complex Arguments
Final rept.
Lawrence Flax, and Janet P. Mason. 27 Apr 76, 29p Rept no. NRL-7997

Descriptors: *Computer programs, *Bessel functions, *Acoustic scattering, Computations, FORTRAN, Special functions(Mathematical).
Identifiers: CDC-3600 computers, CDC-3800 computers.

Subroutines have been written in FORTRAN for the CDC 3600/3800 to evaluate Bessel functions of the first and second kinds for complex arguments. These routines will compute (J sub n)(x + iy) and (Y sub n)(x + iy), where x < or = 0, y > or = 0, and i = the square root of (-1). Using the identity 2/(pi(x + iy)) = J sub(n+1)(x + iy)(Y sub n)(x + iy) - (J sub n)(x + iy)(Y sub(n+1)(x + iy)) as a check, the single-precision version will generate results that are accurate to eight figures or more for arguments equal to (plus or minus 20.0 plus or minus 20.0i) and the double-precision version will generate results that are accurate for seven figures or more for arguments equal to (plus or minus 100.0 plus or minus 20.0i).

AD-A024 688/4CP PC **A02**/MF **A01**
California Univ Los Angeles Western Management Science Inst
A Guided Tour of Recent Practical Advances in Integer Linear Programming
A. M. Geoffrion. Sep 74, 9p Rept no. WMSI Reprint-141
Contract N00014-69-A-0200-4042, Grant NSF-GP-36090
Availability: Pub. in OMEGA, The Int. Jnl. of Mgmt. Sci., v4 n1 p49-57 1976.

Descriptors: *Linear programming, *Integer programming, Computer programs, Algorithms, Reprints.

The field of integer programming has been an extremely active one in recent years. Only a small fraction of the contribution, however, are of demonstrable practical value to practitioners or software designers within the near future. These are the contributions which this paper will attempt to survey. The selections are made on a subjective basis from the published and unpublished literature appearing over the last few years. (Author)

AD-A024 764/3CP PC **A04**/MF **A01**
Naval Postgraduate School Monterey Calif
A Program for the Numerical Solution of Large Sparse Systems of Algebraic and Implicitly Defined Stiff Differential Equations
Technical rept. Oct 75-Apr 76
Richard Franke. May 76, 55p Rept no. NPS-53Fe76051

Descriptors: *Differential equations, *Algebra, *Computer programs, Partial differential equations, Subroutines, Time dependence, Finite element analysis, Data storage systems, Sparse matrix, Linear differential equations, Computer printouts.
Identifiers: Stiff differential equations.

This report documents a program for the numerical solution of large sparse systems of algebraic and implicitly defined stiff differential equations. The principal use is intended to be the solution of differential equations arising from time dependent partial differential equations when the finite element method is used to discretize the space domain. The use of compact matrix storage techniques and iteration for the solution of the quasi-Newton iterates in Gear's method makes the program extremely efficient both in terms of storage requirements and execution times. (Author)

AD-A024 930/0CP PC **A05**/MF **A01**
Naval Postgraduate School Monterey Calif
An Evaluation and Comparison of Three Nonlinear Programming Codes
Master's thesis
Ralph John Waterman. Mar 76, 94p

Descriptors: *Nonlinear programming, *Computer program verification, Comparison, Algorithms, Fortran, Problem solving, Coding, Sequential analysis, Theses.
Identifiers: SUMT computer program, GRG computer program, GRAVES computer program.

This study evaluates and compares the production use of three nonlinear programming codes. The three codes and their developers are: SUMT by W. C. Mylander, R. L. Holmes and G. P. McCormick, GRG by L. S. Lasdon, A. D. Waren, M. W. Ratner and A. Jain, and GRAVES by G. W. Graves. This is the first computer comparison of these three particular codes. Each code was evaluated with respect to the time and sophistication required of the user and the degree of mandatory or potential interaction between the code and the analyst. The comparison criteria were accuracy, robustness, efficiency and ease of utilization. Eight current and realistic test problems employing from 9-100 variables and 2-20 constraints were used. The results revealed that no single code was superior or inferior in all aspects. The choice of an optimal code among these three would be dependent upon the problems to be solved, the ability of the analyst and the desire of the analyst to alter the code for his own purposes. (Author)

AD-A025 101/7CP PC **A04**/MF **A01**
City Univ of New York Graduate School and Univ Center
Table, A PL-1 Program for Computing Certain Integrals of the Product of Three Legendre Polynomials Useful in Computing the Buckling of Thin Walled Spherical Structures
Interim rept.
Harry E. Rauch, Neal H. Jacobs, and Jonathan L. Marz. 1975, 73p AFOSR-TR-76-0552
Grant AF-AFOSR-2063-71

Descriptors: *Spheres, *Shells(Structural forms), *Buckling, *Computer programs, Aeroelasticity, Thin walls, Polynomials, Legendre functions, Nonlinear differential equations, Computerized simulation, Programming languages.
Identifiers: PL/1 programming language, TABLE computer program, SPHERE computer program.

TABLE, a PL/1, double precision program supplies coefficients for the equations solved by SPHERE, which is the program that does the computation for instability of thin-walled spherical structures under external pressure.

AD-A025 134/8CP PC **A03**/MF **A01**
Virginia Polytechnic Inst and State Univ Blacksburg Dept of Aerospace and Ocean Engineering
Notes on the Computation of the Generalized Zeta and Digamma Functions with Programs and Tables
W. H. Mason, and B. E. Nerney. Oct 74, 38p
Rept no. VPI-Aero-023
Contract N00014-72-A-0136-0001

Descriptors: *Functions(Mathematics), *Computations, *Computer applications, *Tables(Data), Computer programs.
Identifiers: *Zeta function, *Digamma function.

Function subprograms for the computation of the digamma function and generalized zeta function

are presented. Some new analytic results are given, and tables of 20 place values of the functions are provided in order to check the computer codes. The digamma function is tabulated for x = 0.5(0.5)10, and the generalized zeta function is given for s = 2(1)42, a = 0.05(.05)1(.1)2(.5)10(1)21.

AD-A025 210/6CP PC **A03**/MF **A01**
Naval Research Lab Washington D C
A Fortran Computer Program for Calculating the Linear Prolate Functions
Final rept.
A. L. Van Buren. 10 May 76, 45p Rept no. NRL-7994

Descriptors: *Computer programs, *Fortran, *Functions(Mathematics), Linear systems, Wave functions, Eigenvectors, Band spectra, Spheres, Memory devices, Time, Bessel functions, Legendre functions.
Identifiers: LINPRO computer program, *Linear prolate functions, Eigenvalues.

The representation of band-limited and time-limited physical processes is greatly facilitated by the use of the linear prolate functions and eigenvalues. These functions possess the powerful property of orthogonality over both a finite interval and the infinite interval. A computer program called LINPRO has been developed to numerically evaluate in double-precision arithmetic the linear prolate functions and eigenvalues for a wide range of order and argument. The program is written in universal Fortran and should run on any computer that accepts this language. This report first describes the theory of the prolate spheroidal wave functions used in the construction of the linear prolate functions and eigenvalues. Next the principal features of the program LINPRO are discussed. Included are descriptions of the parameter input, allowable parameter ranges, required computer storage, computational procedure, accuracy of the results, computation time, and printed output. Finally a sample output and a computer listing of LINPRO are attached as Appendixes. (Author)

AD-A025 726/1CP PC **A07**/MF **A01**
Stanford Univ Calif Systems Optimization Lab
The Solution of Nonlinear Programs using the Generalized Reduced Gradient Method
Technical rept.
Arvind Jain. Mar 76, 131p Rept no. SOL-76-6
Contract N00014-75-C-0267, N00014-75-C-0865

Descriptors: *Nonlinear programming, Algorithms, Subroutines, Fortran, Gradients, Computer program reliability, Solutions(General), Operations research.
Identifiers: *Generalized reduced gradient method.

The Generalized Reduced Gradient Method for nonlinear programming is discussed with emphasis on a fast, reliable computer implementation of the algorithm. The problems studied relate to basis selection, degeneracy, the acceleration of the solution of nonlinear equations, and the design of a mathematical programming system for sparse large scale nonlinear programs. (Author)

AD-A025 896/2CP PC **A04**/MF **A01**
Darcom Intern Training Center Texarkana Tex
Fitting Criteria in Boundary Value Problems
Final rept.
John H. Walker. May 76, 67p Rept no. DARCOM-ITC-02-08-76-009

Descriptors: *Boundary value problems, *Numerical integration, Differential equations, Minimax technique, Least squares method, Computer programs.

Consider the following problem: dy/dx = Ly + f which represents N first order ordinary differential equations. Suppose y = the summation from k=1 to (n+1) of (a sub k)(p sup k) is a solution to the original ODE, where the (a sub k's) are the superposition constants and the (p sup k's) are particular solutions of (1). The solution of the problem becomes one of finding the (a sub k's). Determining the (a sub k's) entails solving an overdetermined set of linear equations with the (a sub k's) as the unknowns. Two methods are presented for solving the overdetermined set of equations and each is evaluated according to specified criteria.

AD-A026 344/2CP MF **A01**
Massachusetts Inst of Tech Cambridge Operations Research Center
Computer Programs for Mathematical Programming Models in Production Planning
Technical rept.
Silvia Pariente, and Arnoldo C. Hax. May 76, 61p Rept no. TR-124
Contract N00014-75-C-0556
Availability: Microfiche copies only.

Descriptors: *Computer programs, *Mathematical programming, *Inventory control, Planning, Cost models, Linear programming, Variables, Work measurement, Work.
Identifiers: *Production planning.

Production is concerned with the determination of production inventory and work force levels to meet fluctuating demand requirements. Mathematical programming is suited particularly well for supporting these types of decisions. The first purpose of this paper is to review the different types of mathematical programming models that can be used to support production planning decisions. The second objective is to describe a set of computer programs that allow the input of model data and the solution of the mathematical programming model. Some computational results are also given. (Author)

AD-A026 446/5CP PC **A05**/MF **A01**
Darcom Intern Training Center Texarkana Tex
Regression with Differential Equation Models
Final rept.
Craig D. Hunter. Apr 76, 99p Rept no. DARCOM-ITC-02-08-76-008

Descriptors: *Regression analysis, *Computer programs, *Mathematical models, *Differential equations, Boundary value problems, Linear systems, Nonlinear systems, Systems analysis, Curve fitting, Statistical analysis, Numerical analysis.
Identifiers: Mass spring damping system.

Regression analysis normally implies the use of algebraic equations to describe a system; however, some cases would better be modeled by differential equations. This is accomplished by assuming a differential equation model for a given set of data and estimating the values of the unkown parameters within the model. These values are then systematically perturbed to generate particular solutions which are superimposed to yield a better estimate of the unknowns. This process is repeated until a specified accuracy is met. Through an analysis of variance, the statistical characteristics of linear regression can be generated for most nth order differential equations. This provides a basis for evaluating the 'acceptance or rejection' of the regression. The characteristics generated consist of an ANOVA table (uncorrected), general F test on the regression, the R2 value, covariance matrix of the superposition constants, an estimate of the variance about the regression, an estimate of the variance of the parameters, and the confidence intervals on these estimates. (Author)

AD-A026 835/9CP PC **A04**/MF **A01**
Harvard Univ Cambridge Mass Div of Engineering and Applied Physics
MIN: An Interactive Educational Program for Function Minimization
Interim technical rept.
R. Muralidharan, and R. K. Jain. Dec 75, 54p Rept no. TR-659
Contract N00014-75-C-0648, Grant NSF-HES73-10323

Descriptors: *Computer programming, *Algorithms, Optimization, Search theory.
Identifiers: *MIN computer program, WANG 2200 computers, BASIC programming language, Davidon-Fletcher-Powell method, Parallel tangent method, Conjugate gradient method, Unconstrained minimization.

MIN is an interactive computer program package for function minimization. It provides building blocks with which a user can construct a program to solve his problem. Moreover, it is an educational tool which helps users 'learn' what is happening by interacting with the program while it is executing, by testing out his intuition, by switching algorithms between iterations, etc. Currently MIN provides a choice of four search direction algorithms (Davidon Fletcher Powell method, Parallel Tangent Method, Fletcher Reeve's Conjugate Gradient Method, and Gradient Method) and five line search algorithms (Golden Section, False Position, High Order, Fibbonacci and DSC-Powell Search). Also it provides several stopping criterion, different output formats, and proper input checking facilities. The package has been written in BASIC language implemented on WANG 2200 computers.

AD-A026 851/6CP PC **A03**/MF **A01**
North Carolina Univ At Chapel Hill
Maximum Likelihood Estimation of the Distribution of the Sum of Three Independent Exponential Random Variables
Technical rept.
George S. Fishman. May 76, 30p Rept no. TR-76-7
Contract N00014-67-A-0321-0008

Descriptors: *Statistical distributions, *Random variables, *Exponential functions, *Computer programs, Computerized simulation, Curve fitting, Covariance, Matrices(Mathematics), Asymptotic series, Fortran, Subroutines, Hypotheses.
Identifiers: Maximum likelihood estimation Parameter estimation, Binary search, Regenerative processes, Covariance matrix, Grid search.

This paper describes a procedure for computing the maximum likelihood estimates of the parameters of the distribution of the sum of three independent exponential random variables. By fitting sample interevent time data from a real system to this distribution, one can create a simulation of the system that exploits the regenerative representation of queueing systems to analyze the simulation's output by relatively elementary statistical methods. The paper also describes computation of the sample asymptotic covariance matrix and an implementation of the likelihood ratio for testing six hypotheses that are special cases of interest. A set of FORTRAN subroutines for executing these procedures appears in the Appendix. (Author)

AD-A027 246/8CP PC **A05**/MF **A01**
Naval Postgraduate School Monterey Calif
Reduced Order Approximations to Higher Order Linear Systems
Master's thesis
Jerry Dennis Thompson. Jun 76, 79p

Descriptors: *Approximation(Mathematics), *Linear systems, *Mathematical programming, Computer programs, Mathematical models, Graphics, Display systems, Tables(Data), Error analysis, Numerical analysis.
Identifiers: Routh approximation method, Dominant pole method.

Low order models are derived by a computer program technique which utilizes the Routh Approximation Method of analysis. Comparisons are made between this method and that of the Dominant Pole Method and the Iterative Optimization Method of analysis. Low order models are developed from higher-order linear systems and compared to that system in response to input excitations consisting of a Step and a Ramp. Graphical displays and numerical tables provide a basis for error analysis and comparisons between the approximation techniques. (Author)

AD-A027 774/9CP PC **A03**/MF **A01**
Missouri Univ Kansas City Dept of Mathematics
Algorithms for Rational Approximations for a Confluent Hypergeometric Function
Yudell L. Luke. 1976, 35p AFOSR-TR-76-0869
Grant AF-AFOSR-2520-73

Descriptors: *Hypergeometric functions, *Approximation, Confluence, Computer programs, FORTRAN, Computations.

Identifiers: Gamma function, IBM 370/68 computers, Pade approximation.

In the authors' volumes on the special functions, rational approximations for the confluent hypergeometric function (z sup a)U(a;c;z) were examined in some detail. This confluent function is very important in the applications since it includes as special cases the incomplete gamma function (special cases of which are exponential, sine and cosine integrals, Fresnel integrals and the error function), Bessel functions, parabolic cylinder functions and Coulomb wave functions. In the special case where a is unity, the confluent function becomes an incomplete gamma function. In this event, complete a priori error analyses for the main diagonal Pade approximations and much more were presented. For general parameters, the rational approximations treated were not of the Pade class. It was shown that the rational approximations converge, but a complete a priori analysis was not available. One of the purposes of this report is to correct this deficiency. FORTRAN programs are provided to evaluate the Pade and non-Pade rational approximations by using the appropriate recursion formulas to generate the numerator and denominator polynomials as a number, and to also evaluate the coefficients which define these polynomials.

AD-A027 963/8CP PC **A04**/MF **A01**
Wisconsin Univ Madison Mathematics Research Center
SOLVEBLOK: A Package for Solving Almost Block Diagonal Linear Systems, with Applications to Spline Approximation and the Numerical Solution of Ordinary Differential Equations
Technical summary rept.
Carl de Boor, and Richard Weiss. May 76, 52p
Rept no. MRC-TSR-1625
Contract DAAG29-75-C-0024

Descriptors: *Computer programming, *Matrices(Mathematics), *Computations, Differential equations, Numerical analysis, Computer programs, FORTRAN, Runge Kutta method, Nonlinear differential equations.
Identifiers: *SOLVEBLOK computer program, Spline approximation, Collocation method, Ordinary differential equations, Sparse matrices.

In spline approximation and in the numerical solution of (systems of) ordinary differential equations, one is eventually faced with linear systems of a rather characteristic, almost block diagonal, form which reflects the underlying geometry of the problems. While these systems could be treated as banded systems, it is more efficient, both in the generation of the systems and in their numerical solution, to work explicitly with their block structure. The report describes a package of FORTRAN routines for the solution of an almost block diagonal system by Gauss elimination with scaled row pivoting. Two examples are given. The first involves the solution of an m-th order ordinary differential equation by collocation. The second example offers a package of routines for the solution of a system of first order ODEs by collection at Lobatto points which is then used on a somewhat tricky reentry problem.

AD-A028 030/5CP PC **A03**/MF **A01**
Cornell Univ Ithaca N Y Dept of Computer Science
On the Reachability Problem for 5-Dimensional Vector Addition Systems
Technical rept.
John Hopcroft, and Jean-Jacques Pansiot. Jun 76, 48p Rept no. CU-CSD-76-280
Contract N00014-67-A-0077-0021

Descriptors: *Set theory, *Computations, Computer applications, Mathematical models, Mathematical logic, Theorems.
Identifiers: Petri nets, *Vector addition systems, *Reachability problem.

The reachability set for vector addition systems of dimension less than equal to five are shown to be effectively computable semilinear sets. Thus reachability, equivalence and containment are decidable up to dimension 5. An example of a non-semilinear reachability set is given for dimension 6.

AD-A028 443/0CP PC **A05**/MF **A01**
Naval Postgraduate School Monterey Calif
An Evaluation and Comparison of Several Single Variable Search Methods
Master's thesis
Daniel Brian Wick. Jun 76, 81p

Descriptors: *Nonlinear programming, *Optimization, *Search theory, Interpolation, Computer programs, Theses.
Identifiers: SUMT computer program, *Penalty functions, Cubic spline technique.

This study compares three single variable search methods - Golden Section, cubic interpolation and quadratic interpolation. The SUMT nonlinear program was used for the comparison. The OPT subroutine which performs the single variable search in SUMT currently uses the Golden Section method. Two different OPT subroutines were written which implemented cubic interpolation and quadratic interpolation. Seven test problems which contained 9-100 variables and 2-20 constraints were used. The comparison was made on computation time per single variable search for the three methods and the number of function evaluations per single variable search for the Golden Section and quadratic interpolation methods. A single variable search by Lasdon, Fox and Ratner and one by Fletcher and McCann were also discussed. The results showed that the quadratic interpolation was slightly faster than the other two methods and required fewer function evaluations per single variable search than the Golden Section method.

AD-A028 497/6CP PC **A06**/MF **A01**
Naval Underwater Systems Center New London Conn New London Lab
Numerical Solutions of Initial Value Problems
Technical rept.
Ding Lee. 23 Jul 76, 118p Rept no. NUSC-TR-5341

Descriptors: *Numerical methods and procedures, *Linear differential equations, Nonlinear differential equations, Computer programs, FORTRAN, Matrices(Mathematics), Problem solving, Systems analysis.
Identifiers: *Initial value problems, UNIVAC-1108 computers, IBM-360/370 computers, CDC-6600 computers.

A family of nonlinear multistep (NLMS) numerical methods has been developed that is particularly effective for solving stiff ordinary differential equations. These methods offer the advantages of avoiding small step sizes and being A-stable in the Dahlquist sense. These advantages over existing conventional and stiff methods have been demonstrated by the present author with a number of test cases. These same methods can also be used to solve nonasymptotically stable differential equations since they are a generalization of Linear Multistep (LMS) methods. This report presents a detailed formulation of NLMS methods and discusses a FORTRAN V computer package specifically developed to implement NLMS methods. The package, also available in ANSI FORTRAN, is presently operational on Univac 1108, IBM 360/370, and CDC 6600 computers. Several desirable features are included in the computer program, namely, a fixed or variable step size, self-start, a selection of characteristic polynomial coefficients, predict-and-correct m times, and the inclusion of LMS methods.

AD-A028 626/0CP PC **A02**/MF **A01**
Royal Aircraft Establishment Farnborough (England)
Generalized Gauss Quadrature Formulae
Technical rept.
J. G. Ballantyne. Feb 76, 13p RAE-TR-76019, DRIC-BR-52039

Descriptors: *Numerical integration, *Gaussian quadrature, Computer programs, Subroutines, FORTRAN, Great Britain.

The n point Gauss quadrature formula is generalized to cover weighted integrals. Computer programs for generating the coefficients of the integration formulae for any given f(x) and w(x) are outlined, methods of handling point constraints and cases of failure are discussed, and some applications of the method briefly mentioned.

AD-A030 090/5CP PC **A04**/MF **A01**
David W Taylor Naval Ship Research and Development Center Bethesda Md Ship Performance Dept
Computer Program for Estimation of Extreme Values Based on the Generalized Gamma Distribution
Michel K. Ochi. May 76, 75p Rept no. SPD-692-01

Descriptors: *Statistical functions, *Computer programs, Computations, FORTRAN, Ship motion, Response, Spectrum analysis, Probability density functions.
Identifiers: *Gamma density functions, CDC-6700 computers, Goodness of fit tests, Order statistics.

This report presents a computerized procedure for evaluating the parameters of the generalized gamma distribution from a set of random data following the method proposed by Stacy and Mihram. The computer program includes the estimation of extreme values for a specified number of observations by applying order statistics. Program listings and an example of the application of the method to surface effect ship motion data are included.

AD-A030 300/8CP PC **A08**/MF **A01**
Army Materiel Command Alexandria Va
Engineering Design Handbook. Development Guide for Reliability. Part Three. Reliability Prediction
6 Jan 76, 175p Rept no. AMCP-706-197
See also Part 4, AD-A027 371.

Descriptors: *Reliability, *Handbooks, Mathematical prediction, Statistical decision theory, Probability, Reliability(Electronics), Redundancy, Monte Carlo method, Computerized simulation, Computer programs.

No abstract available.

AD-A030 611/8CP PC **A03**/MF **A01**
Naval Medical Research Inst Bethesda Md
Iterative Parameter Estimation
Medical research progress rept.
R. Clifton Bailey, and Louis D. Homer. Sep 76, 27p

Descriptors: *Computer programs, *Iterations, Least squares method, Parametric programming, Subroutines, Nonlinear systems, Functions(Mathematics), Medicine.
Identifiers: BASIC programming language, Parameter estimation.

The report describes a non-linear least squares program and a maximum likelihood program for use by persons without extensive statistical or computer experience. Both programs are written in the BASIC computer language. (Author)

AD-A030 689/4CP PC **A02**/MF **A01**
Stanford Univ Calif Systems Optimization Lab
Optimal Design of Pitched Tapered Laminated Wood Beams
Technical rept.
M. Avriel, and J. D. Barrett. May 76, 24p Rept no. SOL-76-9
Contract N00014-75-C-0267, N00014-75-C-0865

Descriptors: *Beams(Structural), *Laminates, *Wood, Structural engineering, Mathematical models, Computer programs, Computerized simulation, Mathematical programming, Optimization.
Identifiers: Pitched tapered beams, Signomial programming.

The optimal design of a pitched tapered laminated woood beam is considered. An engineering formulation is given in which the volume of the beam is minimized. The problem is then reformulated and solved as a generalized geometric (signomial) program. Sample designs are presented. (Author)

AD-A030 690/2CP PC **A04**/MF **A01**
Stanford Univ Calif Systems Optimization Lab
Nonlinear Programming for Large, Sparse Systems
Technical rept.
B. A. Murtagh, and M. A. Saunders. Aug 76, 62p Rept no. SOL-76-15
Contract N00014-75-C-0267, E(04-3)-326

Descriptors: *Nonlinear programming, Algorithms, Sparse matrix, Optimization, Simplex method.
Identifiers: MINOS computer program.

An algorithm for solving large-scale nonlinear programs with linear constraints is presented. The method combines efficient sparse matrix techniques as in the revised simplex method with stable variable-metric methods for handling the nonlinearities. A general-purpose production code (MINOS) is described, along with computational experience on a wide variety of problems. (Author)

AD-A030 692/8CP PC **A03**/MF **A01**
Stanford Univ Calif Systems Optimization Lab
Users Guide for LCPL. A Program for Solving Linear Complementarity Problems by Lemke's Method
Technical rept.
J. A. Tomlin. Aug 76, 36p Rept no. SOL-76-16
Contract N00014-75-C-0865, DAAC29-74-C-0034

Descriptors: *Linear programming, *Computer programming, User needs, Programming manuals, FORTRAN, Input output processing, Quadratic programming, Optimization, Sampling.
Identifiers: *Lemke method, LCPL computer program, *Linear complementarity problem.

This document is a users guide for LCPL, an efficient robust program for solving Linear Complementarity Problems by Lemke's method. (Author)

AD-A031 498/9CP PC **A03**/MF **A01**
Boston Coll Chestnut Hill Mass Space Data Analysis Lab
A FORTRAN Program for Solving Systems of Coupled Second-Order Differential Equations with Two-Point Boundary Conditions
Jeffrey M. Forbes, and Henry B. Garrett. 1 Aug 76, 35p BC-SDAL-77-1, Scientific-1, AFGL-TR-76-0205
Contract F19628-76-C-0059

Descriptors: *Computer programs, *Computer applications, *Differential equations, Algorithms, Digital computers, Partial differential equations, Linear differential equations, Matrices(Mathematics), Boundary value problems, Fortran, Subroutines.
Identifiers: Two point boundary value problems, CDC-6600 computers.

A computer program suitable for use on the CDC 6600 computer has been developed that solves a system of second-order ordinary differential equations with two-point boundary conditions. The program is highly adaptable and can readily be altered to solve a wide variety of second-order partial or ordinary differential equations.

AD-A031 755/2CP PC **A05**/MF **A01**
Naval Underwater Systems Center New London Conn New London Lab
Multivariate Linear Predictive Spectral Analysis Employing Weighted Forward and Backward Averaging: A Generalization of Burg's Algorithm
Technical rept.
Albert H. Nuttall. 13 Oct 76, 100p Rept no. NUSC-TR-5501
See also report dated 19 May 76, AD-A024 982.

Descriptors: *Multivariate analysis, *Spectrum analysis, *Computer programs, FORTRAN, Correlation techniques, Entropy, Algorithms, White noise, Matrices(Mathematics).
Identifiers: Burg algorithm.

A method for multivariate linear predictive spectral analysis, employing weighted forward and backward averaging, is presented and programmed in FORTRAN. The method constitutes a generalization of Burg's univariate algorithm to the multivariate case. The essential analytical procedure is to minimize the trace of the sum of the weighted forward and backward error matrices by choice of the partial correlation coefficients, subject to a linear matrix constraint which guarantees that the forward-extrapolated and backward-extrapolated correlation matrix estimates are Hermitians of each other. The choice of error weighting is important and is discussed. Solution of a bilinear matrix equation is required in the algorithm.

AD-A031 812/1CP PC **A05**/MF **A01**
Naval Surface Weapons Center Dahlgren Lab Va
Computation of the Incomplete Gamma Function Ratios
Final rept.
A. R. DiDonato, and R. K. Hageman. Apr 76, 85p Rept no. NSWC/DL-TR-3482

Descriptors: *Special functions(Mathematical), *Computations, *Computer programs, Algorithms, FORTRAN.
Identifiers: *Gamma function, CDC-6700 computers.

A method, made up of several algorithms, is given for computing the incomplete gamma function ratio, P(a, x) and its complement Q(a, x) for all real arguments $a > 0$, $x >$ or $= 0$. The difficult case when a and x are large is treated by a modified version of Takenaga's method. The resulting computer program is efficient, yields both P and Q correctly to within 1 unit in the twelfth significant digit, or, at the user's option, to within one unit in the sixth or third significant digit. A FORTRAN listing of the program is included.

AD-A031 817/0CP PC **A05**/MF **A01**
Naval Postgraduate School Monterey Calif
Accuracy Analysis for a Lower Confidence Limit Procedure for System Reliability
Master's thesis
Thomas Robert Gatliffe. Sep 76, 98p

Descriptors: *Reliability, *Confidence limits, Estimates, Statistical tests, Probability density functions, Tables(Data), Theses, Computerized simulation, Computer programs, FORTRAN.
Identifiers: Parameter estimation, Log gamma density functions, FORTRAN 4 programming language, IBM-360 computers.

This thesis examines a proposed empirical method for determining the 100 (1-alpha) per cent lower confidence limit for the reliability of a system composed of a mixture of series and parallel connected components for which only component level test data is available. The method is an extension of the Log-gamma procedure originally proposed for series connected systems only. The accuracy of the method is assessed for some representative system reliability constructs using a computer simulation procedure. The simulation results are examined with a view toward identification of accuracy indication parameters which may be estimated prior to the component tests.

AD-A031 935/0CP PC **A05**/MF **A01**
Rice Univ Houston Tex Aero-Astronautics Group
Numerical Methods in Aerospace Systems Theory
Final rept. 1 Oct 71-31 Aug 76
Angelo Miele. 1976, 84p AAR-132, AFOSR-TR-76-1085
Grant AF-AFOSR-2185-72

Descriptors: *Numerical methods and procedures, *Aerospace systems, *Nonlinear differential equations, *Mathematical programming, Optimization, Flight paths, Exosphere, Boundary value problems, Algorithms, Transformations(Mathematics), Gradients, Aerodynamic configurations, Digital computers, Computer programs.
Identifiers: *Control theory.

This document summarizes the research performed at Rice University during the period 1971-76 under Air Force Grant No. AF-AFOSR-72-2185 in several areas of numerical analysis of interest in aerospace systems theory, namely: (i) solution of nonlinear equations, (ii) solution of differential equations, (iii) mathematical programming problems, and (iv) optimal control problems. The work summarized here is eminently applicable to these areas of aerospace engineering: (i) optimum atmospheric flight trajectories, (ii) optimum extra-atmospheric flight trajectories, (iii) optimum aerodynamic shapes, and (iv) optimum structures. (Author)

AD-A032 013/5CP PC **A03**/MF **A01**
Maryland Univ College Park Dept of Computer Science
An Algorithm for Computing Reducing Subspaces by Block Diagonalization
Technical rept.
Connice A. Bavely, and G. W. Stewart. Oct 76, 46p Rept no. TR-489
Contract N00014-76-C-0391

Descriptors: *Algorithms, *Matrices(Mathematics), *Transformations(Mathematics), Computer programs, Eigenvalues, Eigenvectors, Computations, Structures, Reduction.
Identifiers: Reducing subspaces, Block diagonalization.

This paper describes an algorithm for reducing a real matrix A to block diagonal form by a real similarity transformation. The columns of the transformation corresponding to a block span a reducing subspace of A, and the block is the representation of A in that subspace with respect to the basis. The algorithm attempts to control the condition of the transformation matrices, so that the reducing subspaces are well conditioned and the basis vectors are numerically independent. (Author)

AD-A032 046/5CP PC **A02**/MF **A01**
Naval Research Lab Washington D C
Numerical Solution of the Parabolic Equation with the PEP Code
Memorandum rept.
B. E. McDonald. Oct 76, 19p Rept no. NRL-MR-3385

Descriptors: *Wave propagation, *Finite difference theory, Numerical integration, Wave equations, Stability, Refraction, Approximation(Mathematics).
Identifiers: PEP computer program, Leapfrog Methods, Parabolic differential equations.

Proposed is a centered leapfrog difference scheme for solution of the parabolic equation for wave propagation in random media. Stability and resolution requirements for the scheme are given. Results of two numerical integrations are in good agreement with those obtained by other using different methods.

AD-A032 051/5CP PC **A03**/MF **A01**
Desmatics Inc State College Pa
Optimization of a Computer Simulation Response
Technical rept.
Dennis E. Smith. Nov 76, 39p Rept no. TR-106-3
Contract N00014-75-C-1054
Presented at the ORSA/TIMS Joint National Meeting, 3-5 Nov 76, Miami, Fla.

Descriptors: *Computerized simulation, Problem solving, Computer programs, Research management, Optimization, Interfaces, Response, Input, Output.
Identifiers: Response surface analysis, *Statistical analysis.

Based on results to date, the statistical techniques of Response Surface Methodology (RSM) appear to be well-adapted to use in seeking an optimum simulation response. This report summarizes the optimum-seeking problem, reviews the framework of RSM, and describes an automated RSM computer program which has been developed as an alternative to manual applications of these statistical techniques. Program interface and data preparation are discussed. In addition, easily-followed examples are presented to illustrate program output and major aspects of the RSM optimum-seeking process. (Author)

AD-A032 134/9CP PC **A04**/MF **A01**
Massachusetts Inst of Tech Cambridge Electronic Systems Lab
Shortest Route Algorithms for Sparsely Connected Networks
Technical rept.
Joe E. Defenderfer. Aug 76, 73p Rept no. ESL-R-683
Contract N00014-75-C-1183, ARPA Order-3045

Descriptors: *Networks, *Routing, Combinatorial analysis, Computer programs, Algorithms, Topology, Optimization.
Identifiers: Trees(Mathematics), *Shortest route method, Decomposition method, Network flows.

This report studies the shortest route problem for networks that are less fully connected. Two algorithms are presented which exploit the absence of arcs in solving the shortest route problem. The first, which is designated the NXN algorithm, would tend to be the more applicable to networks typically encountered in practice. The second, which is an improvement on Hu's decomposition shortest route algorithm, is more efficient for a small class of networks; however, it generally requires less memory to hold the required decomposition information in the computer than does the NXN algorithm. (Author)

AD-A032 145/5CP PC **A06**/MF **A01**
Systems Control Inc Palo Alto Calif
Methods for the Real Time Identification of Vehicle Parameters
Engineering technical rept. 1 Jan-31 Dec 74
N. K. Gupta, and W. E. Hall. Feb 75, 119p
Contract N00014-72-C-0328

Descriptors: *Algorithms, *Test and evaluation, Computer programs, Data processing, Real time, On line systems, Identification systems, Nonlinear systems, Parametric programming, Aircraft, Guided missiles, Ships, Underwater vehicles.
Identifiers: Parameter estimation, Maximum likelihood estimation, *Statistical analysis.

This report presents two methods for on-line and real time estimation of parameters for application to aircraft, missiles, surface and subsurface marine vehicles and various subsystems. The first method is based on the instrumental variables approach. A new technique for choosing the instrument matrices is developed. This technique ensures algorithm convergence even with bad initial conditions and when the system parameters change. The second method uses the sensitivity functions reductions technique in the maximum likelihood approach to give a viable on-line or real time method. A maximum likelihood approach is also suggested for nonlinear systems. The trade offs of the two methods are discussed. These techniques are applied to simulation and flight test data. Excellent results are obtained in both cases. (Author)

AD-A032 579/5CP PC **A06**/MF **A01**
Rand Corp Santa Monica Calif
CURVES: A Cost Analysis Curve-Fitting Program
Interim rept.
H. E. Boren, Jr, and G. W. Corwin. Sep 76, 118p
Rept no. R-1753-1-PR
Contract F44620-73-C-0011
Errata sheet inserted. Supersedes Rept. no. R-1753-PR, AD-A020 141.

Descriptors: *Curve fitting, *Computer programs, Cost analysis, Cost effectiveness, Statistical analysis, Regression analysis, Least squares method, Variables, Equations, Transformations(Mathematics), Error analysis, Plotters, Fortran, Subroutines, Flow charting.
Identifiers: *CURVES computer program.

This report describes a FORTRAN-IV curve-fitting computer program (CURVES) that makes least-squares determinations of the parameters of any of eight types of equations selected by the user, given a set of observations on the dependent and independent variables of interest. The types of equations that can be fitted are: linear, quadratic, power, asymptotic-power, exponential, logarithmic-linear, and two types of semilogarithmic-linear. Except for the quadratic and asymptotic-power equations, up to seven independent variables may be used. Y-intercepts may be specified for all equations except the power and exponential.

AD-A032 664/5CP PC **A03**/MF **A01**
Lockheed Missiles and Space Co Inc Palo Alto Calif Palo Alto Research Lab
SLICE 75, A Computer Program for Large, Symmetric Eigenvalue Problems
Final rept.
Paul S. Jensen. Sep 76, 50p LMSC/D508885, AFOSR-TR-76-1144
Contract F44620-71-C-0109

Descriptors: *Computer programs, *Eigenvalues, *Eigenvectors, Partial differential equations, Mathematical programming, Data management, Numerical analysis, Matrices(Mathematics), Algorithms, Costs, Errors.
Identifiers: *SLICE 75 computer program, Sparse matrix.

SLICE 75 is a computer program for eigenvalue and eigenvector analysis of the generalized, symmetric problem $S x + Mx$, where M is non-negative definite. It is particularly suited for obtaining a few select eigenvalues and eigenvectors of a large, sparse system of equations. Comprehensive documentation of SLICE 75 is provided including detailed descriptions of the mathematical, numerical and implementation systems used. Operational procedures are also discussed and illustrated with output from sample program executions. SLICE 75 uses a general storage management system AID and a number of utility programs which are documents in the Appendixes of this report. (Author)

AD-A032 719/7CP PC **A08**/MF **A01**
Naval Academy Annapolis Md
Mathematical-Statistical and Digital Computer Analysis of Time Series Data
Research rept.
Steven J. Raher. 17 May 76, 159p Rept no. USNA-TSPR-81
Report on a Trident scholar project.

Descriptors: *Time series analysis, *Computer programs, Correlation techniques, Cross correlation, Autocorrelation, Fourier transformation, Fast fourier transforms, Fourier analysis, Regression analysis, Multichannel, Random variables, Covariance, Digital filters, Trends, Estimates, Digital computers, FORTRAN.

The purpose of this study is to develop a series of computer programs for use in analyzing time series data (waves) - such as EEG readings. Programs were used to produce reliable estimates of correlations, spectra, cross spectra, and partial coherences of multi-channel random processes. The software package was written to be easily adaptable to different sampling rates, amounts of data, and numbers of channels. Provisions for digital prefiltering of data, detrending, and smoothing (using a number of lag windows) were also included. Techniques for estimation of spectra by fitting single- and multi-channel autoregressive schemes to sampled data were also applied and found to yield results consistent with the other methods. (Author)

AD-A032 910/2CP PC **A03**/MF **A01**
Missouri Univ Kansas City Dept of Mathematics
Algorithms for Rational Approximations for a Confluent Hypergeometric Function II
Interim rept.
Yudell L. Luke. 1 Sep 76, 36p AFOSR-TR-76-1165
Grant AF-AFOSR-2520-73

Descriptors: *Hypergeometric functions, *Approximation(Mathematics), Mathematical logic, Numerical methods and procedures, Polynomials, Coefficients, Asymptotic series, Algorithms, Computer programs, Fortran, Subroutines.
Identifiers: Pade approximants.

This is a sequel to a previous paper where rational approximations for the confluent hypergeometric function were treated. Here we take up rational approximations for (1)F(1)(a;c;-z). The confluent functions are very important in the applications since they include as special cases the incomplete gamma function Bessel functions, parabolic cylinder functions and Coulomb wave functions. In the special case where a is unity, the confluent function becomes an incomplete gamma function. In this event, complete a priori error analyses for the main diagonal Pade approximations and much more were presented. For general parameters, the rational approximations treated were not of the Pade class. It was shown that the rational approximations converge, but a complete a priori analysis was not available. One of the purposes of this report is to correct this deficiency.

AD-A033 321/1CP PC **A04**/MF **A01**
Stanford Univ Calif Systems Optimization Lab
Programmers Guide to LCPL: A Program for Solving Linear Complementarity Problems by Lemke's Method
Technical rept.
J. A. Tomlin. Oct 76, 58p Rept no. SOL-76-25
Contract N00014-75-C-0865, DAAC29-74-C-0034

Descriptors: *Mathematical programming, Quadratic programming, Sparse matrix, Computer programs, Programming manuals, Linear programming, Fortran, Matrices(Mathematics).
Identifiers: *Complementarity problem, Lemke method.

This report gives programmers information and documentation for LCPL--an efficient robust program for solving Linear Complementarity Problems by Lemke's Method. (Author)

AD-A033 441/7CP PC **A04**/MF **A01**
Southern Methodist Univ Dallas Tex Dept of Statistics
REGRESS: A Biased Regression Package
Technical rept.
Robert F. Pierce. 1 Oct 76, 63p TR-124, AFOSR-TR-76-1257
Grant AF-AFOSR-2871-75

Descriptors: *Linear regression analyses, Bias, Computer programs, Least squares method, FORTRAN.
Identifiers: *REGRESS computer program.

REGRESS is a linear multiple regression package consisting of programs capable of providing the computations necessary for Ordinary Least Squares Regression Analysis (OLS), Latent Root Regression Analysis (LRRA), Principle Component Regression Analysis (PCR), Ridge Regression Analysis (RRA), and a Baranchik (James-Stein) Shruken Estimator (BSE). The user may call any or all of these analyses. The purpose of Regress is to bring OLS and four methods of biased regression together in one user-oriented package so the user can more easily analyze data which may be subject to multicollinearities. (Author)

AD-A033 486/2CP PC **A02**/MF **A01**
Yale Univ New Haven Conn Dept of Computer Science
Considerations in the Design of Software for Sparse Gaussian Elimination
Research rept.
S. C. Eisenstat, M. H. Schutz, and A. H. Sherman. 1975, 11p Rept no. RR-55
Contract N00014-67-A-0097-0016

Descriptors: *Computer programming, Sparse matrix, Linear systems, Gaussian quadrature, Machine coding, Computer programs, Experimental design, Trade off analyses, Cost analysis, Multipurpose, Data storage systems.

This paper discusses the design of sparse Gaussian elimination codes, in particular the effects of certain flexibility and cost constraints on the design, and possible tradeoffs among the design goals of flexibility, speed, and small size.

AD-A033 707/1CP PC **A02**/MF **A01**
Naval Postgraduate School Monterey Calif
SASE VI and the Statistical Analysis of Series in Event in Computer Systems
Technical rept.

Peter A. W. Lewis. Sep 76, 23p Rept no. NPS-55Lw76091

Descriptors: *Statistical analysis, *Point processes, Multivariate analysis, Series(Mathematics), Random variables, Poisson density functions, Counting, Spectrum analysis, Trends, Cycles, Mathematical models, Methodology, Computer programs, Subroutines, Fortran.
Identifiers: *SASE 6 computer program, Renewal processes.

Recent results in the development of methodology for the statistical analysis of univariate series of events (point processes) are described and some references to applications in the analysis and evaluation of computer system performance data are given. In addition, described is the SASE VI program which has been developed to implement a methodology for the statistical analysis of a series of events. Various subroutines perform, among other things, tests for monotone and cyclic trends, tests for renewal and Poisson processes and two different types of spectral analysis. The program can also be used to analyze any series of positive random variables such as counts of events in successive fired time intervals in a point process. It has been programmed in both FORTRAN and APL.

AD-A033 717/0CP PC **A04**/MF **A01**
Syracuse Univ N Y
Some Further Considerations on the Estimation of Error of Misclassification Based on the Design Set
Technical rept. Jun 75-Jun 76
Kishan Mehrotra. Oct 76, 52p RADC-TR-76-322
Contract F30602-75-C-0121

Descriptors: *Discriminate analysis, *Error analysis, Analysis of variance, Classification, Estimates, Errors, Linearity, Mean, Normal distribution, Samplers, Pattern recognition, Bayes theorem, Random variables, Gaussian quadrature, Numerical analysis, Computer programs, Algorithms.

Estimates of the variance of the estimated probability of error for linear classifiers under normal distributions are calculated as related to dimensionality and the number of features. (Author)

AD-A033 948/1CP PC **A08**/MF **A01**
Stanford Univ Calif Dept of Operations Research
Computer Programs for Decomposition in Integer Programming
Technical rept.
Gary A. Kochman. Sep 76, 167p Rept no. TR-71
Contract N00014-76-C-0418, DAAC29-74-C-0034

Descriptors: *Integer programming, *Computer programs, Machine coding, Decomposition, Algorithms, Subroutines.

This report gives documentations for two computer coded, DSLC and DMLC for solving block angular integer programming problems. The first code, DSLC, is for the single linking constraint case and the second DMLC is for the multiple linking constraint case. (Author)

AD-A034 033/1CP PC **A03**/MF **A01**
Naval Research Lab Washington D C
Mean and Variance of the Correlation Magnitude of Random and Pseudonoise Sequences
Interim rept.
Loren S. Bearce, and Arthur J. Ziffer. 24 Nov 76, 29p Rept no. NRL-8068

Descriptors: *Pseudorandom sequences, Cross correlation, Spread spectrum, Binary processors, Pseudo noise systems, Fortran, Computer programs.

The mean or expected value and the variance of the absolute value of correlation between equal-length independent random sequences have been determined and compared with the same measures for full-period pseudonoise (PN) sequences, which have applied extensively in spread-spectrum radio communications systems. The magnitude of correlation is often of primary interest in such applications, since a strong negative correlation is as significant as a strong positive correlation; hence correlation detectors exist which function on the basis of the magnitude of correlation. The comparison reveals several advantages of the Gold codes which are due to their inherent mutual orthogonality. The study of random codes permits the performance evaluation of such detectors during periods of noise-only input and also provides a long-needed point of reference for PN system design. (Author)

AD-A034 047/1CP PC **A07**/MF **A01**
Boston Coll Chestnut Hill Mass Space Data Analysis Lab
Numerical and Data Analysis Techniques Applied to Scientific Research. II
Final rept. 1 Jan 73-31 Dec 75
Joseph E. Martine, and Leo F. Power, Jr. 31 Mar 76, 136p BC-SDAL-76-2, AFGL-TR-76-0091
Contract F19628-73-C-0136
See also report dated 31 Jan 73, AD-767 607.

Descriptors: *Numerical analysis, *Computer programming, Mathematical analysis, Mathematical models, Numerical integration, Integral equations, Fourier analysis, Curve fitting, Partial differential equations, Data processing, Physics, Chemistry, Scientific research.
Identifiers: Applications of mathematics.

This report describes selected mathematical analysis, numerical analysis, and computer programming problems. Each problem selected is presented in capsule form and the analysis and computer techniques are outlined.

AD-A034 434/1CP PC **A02**/MF **A01**
Ballistic Research Labs Aberdeen Proving Ground Md
Factorial and Hadamard Series for Bessel Functions of Orders Zero and One
Memorandum rept.
Alexander S. Elder, and Emma M. Wineholt. Dec 76, 20p

Descriptors: *Series(Mathematics), *Bessel functions, Computer programs, Asymptotic series, Functions(Mathematics), Fortran, Input output processing, Tabulation processes.
Identifiers: Factorial series, Hadamard series, Kummer functions, Stirling numbers, Incomplete gamma function.

Bessel functions of orders zero and one for moderate and large positve arguments have been programmed in FORTRAN using factorial series for J sub n(x), Y sub n(x) and K sub n(x) and Hadamard series for I sub n (x). A subroutine to calculate Stirling numbers of the first kind was developed for use in the factorial series. The recurrence relation was modified and the resulting Stirling numbers scaled so that the entire range of the computer was utilized; e.g., 10 to the minus 150th power $< s <$ 10 to the 150th power instead of $< s <$ 10 to the 150th power. In this way, more terms of the series can be calculated and higher accuracy obtained. For use in the Hadamard series, a subroutine to calculate incomplete gamma functions was developed. Various algorithms were necessary to encompass the required range of arguments. These programs were devised to verify the accuracy (for moderate and large arguments) of our previously developed Bessel function subroutine. These programs replace the asymptotic series with convergent series, which, of course, is desirable. Extension of the program to complex arguments is now in progress.

AD-A034 480/4CP PC **A02**/MF **A01**
Wisconsin Univ Madison Mathematics Research Center
Application of Interval Analysis to Error Control
Technical summary rept.
J. M. Yohe. Sep 76, 16p Rept no. MRC-TSR-1686
Contract DAAG29-75-C-0024

Descriptors: *Error analysis, *Computations, Digital computers, Algorithms, Production control, Real variables, Numerical methods and procedures, Quadratic equations, Truncation, Errors, Computer programs.
Identifiers: Univac 1110 computers, Roundoff errors, Interval arithmetic.

Simple examples are given of ways in which interval arithmetic can be used to alert instabilities in computer algorithms, roundoff error accumulation, and even the effects of hardware inadequacies. This paper is primarily tutorial. (Author)

AD-A034 666/8CP PC **A03**/MF **A01**
Harry Diamond Labs Adelphi Md
A Program for the Numerical Inversion of the Laplace Transform
Technical rept.
Arthur Hausner. Aug 75, 47p Rept no. HDL-TR-1707

Descriptors: *Laplace transformation, *Computations, Inversion, Computer programs, Numerical integration.

A program is given that numerically inverts a given Laplace transform for discrete times specified by the user, and (most of the time) to within a specified absolute error. The computation is adaptive in that the program decides whether to compute a given point by integrating the Bromwich integral or to interpolate the point from the set of those already computed by integrating the Bromwich integral. If the integration is performed, it is done by accelerating partial sums to the limit, with the partial sums obtained by Gaussian quadrature with error control. Three examples, including two in which the transform is not the quotient of polynomials, indicate that the reliability of the program is good.

AD-A034 799/7CP PC **A02**/MF **A01**
University of Southern California Los Angeles Dept of Quantitative Business Analysis
Decision Making with the Aid of a Subjective Prior Distribution
Technical rept.
George J. Schick, and Chi-Yuan Lin. Jul 76, 22p Rept no. USC-WP-9-7-1976
Contract N00014-75-C-0733

Descriptors: *Decision theory, *Interactive graphics, Computer programs, Cathode ray tube screens, Bayes theorem, Uncertainty, Probability distribution functions.

This paper discusses a methodology to establish a subjective prior distribution via an interactive computer program on a CRT. The program asks specific carefully worded questions. The answers to these questions are checked for logical consistency and are translated into fractiles of a subjective probability distribution. The fractiles as well as other summary measures (like the mean and variance) are printed out. In order to find a conjugate prior distribution for a Bayesian treatment, the mathematical form of a possible conjugate prior needs to be ascertained. The paper illustrates how the parameters of a lognormal distribution might be obtained from the fractiles of the subjectively derived prior. (Author)

AD-A034 845/8CP PC **A03**/MF **A01**
Naval Research Lab Washington D C
Vectorized Tridiagonal Solvers
Memorandum rept.
J. P. Boris. Nov 76, 41p Rept no. NRL-MR-3408

Descriptors: *Parallel processors, *Linear algebraic equations, *Computations, Matrices(Mathematics), Computer programs, Algorithms, FORTRAN.
Identifiers: *Tridiagonal matrices.

This report briefly documents four related tridiagonal solvers optimized for parallel computation on the ASC computer at NRL. Both single and double precision versions are available. The report also contains listings of the routines and a test program with results for a standard test problem.

AD-A034 999/3CP PC **A14**/MF **A01**
Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering
Sequential Probability Ratio Tests of the Scale Parameter between Two Weibull Distributions with Known Shape Parameter
Master's thesis
James Norris Robinson. Dec 76, 315p Rept no. GOR/MA/76D-2

Descriptors: *Weibull density functions, *Probability distribution functions, Ratios, Parameters, Shape, Discrimination, Failure, Replacement, Risk analysis, Sequential analysis, Exponential functions, Truncation, Computer programs, Monte Carlo method, Computerized simulation, Cost models, Quality control, Reliability, Theses.
Identifiers: Sequential probability ratio tests.

Three types of Weibull sequential probability ratio tests between specified scale parameters are examined when the shape parameter of the distribution is assumed known. The three types of testing are: one test unit tested at a time with replacement on failure, n units on test without replacement (dependent sample), and n' units on test with replacement on failure. A new test statistic is presented for the third type. Truncated test plans representing 40 possible shape parameters ranging from .50 to 5.70 are presented for four sets of designated risks. Designated risks for equal Type I and Type II errors are 0.5, .10, .20, and .30. Monte Carlo computer simulations are used to evaluate the test plans in terms of actual risks and actual expected time and failure number to decision underH0 and HA.

AD-A035 458/9CP PC **A05**/MF **A01**
Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering
A Monte Carlo Study of Composite Sequential Likelihood Ratio Tests for the Weibull Scale Parameter
Master's thesis
Richard L. Hoffert. Dec 76, 98p Rept no. GOR/MA/76-1

Descriptors: *Weibull density functions, *Sequential analysis, Ratios, Test methods, Monte Carlo method, Scaling factors, Parameters, Error analysis, Estimates, Truncation, Computer programs, Theses.
Identifiers: *Weibull distribution functions.

Three Sequential Likelihood Ratio Tests were constructed to choose between two values of the scale parameter (theta) of a Weibull distribution with a location parameter of zero, an unknown shape parameter (K) replaced by its maximum likelihood estimate, and error bounds of 0.05, 0.10, 0.15, and 0.20. The first two tests were based upon a general procedure for sequential tests for a parameter in the presence of a nuisance parameter by D. R. Cox in Sankhya A, Vol. 25. This method replaces the likelihood ratio with an asymptotically equivalent test statistic. The tests were then truncated and the effects of this truncation upon the error bounds were studied.

AD-A035 485/2CP PC **A03**/MF **A01**
Frank J Seiler Research Lab United States Air Force Academy Colo
Minimum Distance Least Squares Surface Fitting
Technical rept. Apr 75-Dec 76
Armand A. Fannin, Jr, and Lowell A. King. Dec 76, 49p Rept no. FJSRL-TR-76-0019

Descriptors: *Curve fitting, *Least squares method, Data reduction, Error analysis, Variables, Estimates, Vapor pressure, Measurement, Computer programs.

A least squares fitting technique is described where all of the experimental variables are considered subject to error, rather than the customary single variable. The procedure is particularly valuable when the actual physical measurements contain real and estimable errors in more than one variable. The fitting procedure minimizes the closest (perpendicular) distance from the experimental point to the locus on the assumed functional relationship among the n different variables. The locus is approximated by a (n-1) dimensional surface. The techique is adaptable to any number of variables and any number of adjustable constants in the assumed equation.

AD-A035 733/5CP PC **A05**/MF **A01**
California Univ Berkeley Operations Research Center
Everyman's Guide to TIMES
Research rept.
Randall R. Willie. Jan 77, 100 Rept no. ORC-77-2
Grant AF-AFOSR-3179-77

Descriptors: *Computer programming, *Time series analysis, *Forecasting, Transfer functions, Mathematical models, Curve fitting, Fortran, Plotting.
Identifiers: *TIMES computer program, Box-Jenkins method, Fast Fourier transform.

This is a user's manual for the TIMES computer program, an integrated system of FORTRAN subroutines for modelling of a single time series and for transfer function modelling with a single input series. TIMES is an extension and adaptation of a widely used system available from the Ohio State University Computer Center Library. This document is a refinement of an earlier guide prepared for classroom use during Spring Quarter, 1976, at the Department of Industrial Engineering and Operations Research, University of California, Berkeley.

AD-A035 777/2CP PC **A05**/MF **A01**
Aberdeen Univ (Scotland)
Enumeration of Large Combinatorial Structures
Annual technical rept. no. 2 (Final) Nov 75-Nov 76
E. M. Wright. Nov 76, 91p
Grant DA-ERO-75-G-014

Descriptors: *Combinatorial analysis, *Graphs, Integration, Computations, Computer programs, Computer applications, Theory, Polynomials, Theorems, Great Britain.

Two methods are described to determine exact formulae for the number of labelled connected graphs on n points and n+k edges for general n and different values of k. One method supplies an essential piece of information for general k; given this, the other is much more efficient and is well-adapted to machine computation. The first method is extended to several other problems but has to replace the second by a different method for each problem. According to Temperley, at least two of the problems are of physical interest. In addition three problems were solved about the properties and the evolution of almost all large graphs. The appendices consist of six research papers, of these one contains computer results connected with these problems.

AD-A035 795/4CP PC **A02**/MF **A01**
California Univ Berkeley Dept of Electrical Engineering and Computer Sciences
Decomposition of a Symmetric Matrix
James R. Bunch, Linda Kaufman, and Beresford N. Parlett. 6 Oct 75, 15p
Availability: Pub. in Numerisch Mathematik, v27 p95-109 1976.

Descriptors: *Matrices(Mathematics), Algorithms, Decomposition, Handbooks, Linear algebra, Symmetry, Linear programming, Reprints.
Identifiers: Algol programming language, *Computer programs, Symmetric matrices.

An algorithm is presented to compute a triangular factorization and the inertia of a symmetric matrix. The algorithm is stable even when the matrix is not positive definite and is as fast as Cholesky. Programs for solving associated systems of linear equations are included. (Author)

AD-A037 019/7CP PC **A04**/MF **A01**
New Jersey Inst of Tech Newark
An Improved Direct Search Numerical Optimization Procedure
Interim rept.
Michael Pappas. Feb 77, 61p Rept no. NJIT-NV-10
Contract N00014-75-C-0987

Descriptors: *Mathematical programming, *Optimization, Algorithms, Nonlinear analysis, Computer aided design, Computer programs, FORTRAN, Machine coding.
Identifiers: Constraints.

An improved, nonlinear, constrained mathematical programming optimization algorithm coupling a rotating coordinate pattern search with a feasible direction finding procedure used at points of pattern search termination is presented. The procedure is compared with nineteen popular algorithms, on ten test problems in which the majority of codes failed at least 50% of the time. Only the new method solved all problems, particularly in the case of constrained problems where it was best. (Author)

AD-A037 491/8CP PC **A02**/MF **A01**
Syracuse Univ N Y Dept of Industrial Engineering and Operations Research
Thinning of a Point Process Over Time
Interim rept.
Richard F. Serfozo. 1976, 21p AFOSR-TR-77-0122
Grant AF-AFOSR-2627-74, NSF-ENG-75-13653

Descriptors: *Point processes, *Statistical processes, Random variables, Computer programs, Debugging(Computers), Signal processing, Poisson density functions.

Thinning of a point process refers to the procedure in which points are randomly placed in a region and then they are deleted according to some rule. The aim is to answer questions such as (1) how can the random placement and detection of points be described mathematically; (2) what types of thinned processes arise from various thinning rules; (3) how much thinning is needed for a desired rarefaction of points; and (4) when does one reach diminishing returns in thinning. Examples of thinning procedures are debugging of computer programs and complex systems, filtration of particles from a solution, and the elimination of undesirable cell growth, insects or plants. This paper addresses several thinnings in which points are deleted over time. We show how the asymptotic behavior of a thinned process is equivalent to that of extreme values of the lives of its points under the thinning. We use this to describe independent, regenerative, and semi-stationary thinnings.

AD-A037 894/3CP PC **A02**/MF **A01**
Rand Corp Santa Monica Calif
LIMDEP - A Regression Program for Limited Dependent Variables
Charles E. Phelps. Jul 76, 23p Rept no. P-5696

Descriptors: *Regression analysis, Computer programs, Variables, Fortran.
Identifiers: Limdep computer program.

LIMDEP (Version Phelps) is a Fortran IV (System 370) program for performing regressions using the limited dependent variable technique. The program is wholly double precision, although each observation is read in as a single precision vector, thus permitting the use of F and E formats. Provision is made in the program for performing regressions with the observations weighted. Weights are automatically normalized. Data may be supplied either on cards or on tape or disk input.

AD-A037 900/8CP PC **A02**/MF **A01**
David W Taylor Naval Ship Research and Development Center Bethesda Md
GIVENS: An Out-of-Core Eigensystem Subroutine for Large Order Symmetric Matrices
Research and development rept.
Donald A. Gignac. Feb 77, 20p Rept no. DTNSRDC-77-0025

Descriptors: *Computer programs, *Matrices(Mathematics), Symmetry, Fortran, Subroutines, Mathematical analysis, Eigenvalues, Ei-

genvectors, Computations, Finite element analysis, Inverse problems, Iterations.
Identifiers: Givens computer program.

The need to compute eigenvalues and eigenvectors for large order symmetric matrices arises frequently in the finite element approach to static structural analysis as well as in the applied work of many other fields in the Navy's varied research program. GIVENS is an out-of-core FORTRAN callable eigen-system subroutine which computes all the eigenvalues and specified eigenvectors for a large order real symmetric matrix using modifications of the GIVENS tridiagonalization procedure, the QR method of Francis, and inverse iteration. (Author)

AD-A037 971/9CP PC **A06**/MF **A01**
Michigan Univ Ann Arbor Systems Engineering Lab
Vectorized General Sparsity Algorithms with Backing Store
Interim rept.
D. A. Calahan, P. G. Buning, and W. N. Joy. 15 Jan 77, 117p SEL-96, AFOSR-TR-77-0259
Grant AF-AFOSR-2812-75

Descriptors: *Parallel processing, *Computations, *Algorithms, Vector analysis, Sparse matrix, Numerical methods and procedures, Solutions(General), Differential equations, Simultaneous equations, Linear algebra, Finite element analysis, FLOW CHARTING, Computer programs.

The direct solution of large, sparse unsymmetric sets of simultaneous equations is commonly involved in the numerical solution of algebraic, differential, and partial differential equations. This report describes two new clases of computational algorithms for the solution of such equations. Each algorithm detects matrix structure suitable for vector processing and, potentially, for faster processing on cache machines. One procedure favors structure usually associated with small sparse matrices; one is directed toward sets of equations requiring a large backing store. Comparisons of timing (on a chache machine) and of memory requirements are made between these new procedures and existing general sparsity techniques for a variety of science-engineering examples. Issues related to implementation are given for software implementations of the two algorithms. (Author)

AD-A038 322/4CP PC **A08**/MF **A01**
Stanford Univ Calif Systems Optimization Lab
Computer Programs for Decomposition in Integer Programming
Technical rept.
Gary A. Kochman. Sep 76, 165p SOL-76-20, ARO-12215.13-M
Contract N00014-76-C-0418, DAAC29-74-C-0079

Descriptors: *Computer programs, *Integer programming, Decomposition, Mathematical programming, Algorithms, Machine coding, Subroutines, Fortran.
Identifiers: Constraints.

This report gives documentations for two computer codes, DSLC and DMLC for solving block angular integer programming problems. The first code, DSLC, is for the single linking constraint case and the second DMLC is for the multiple linking constraint case. (Author)

AD-A038 436/2CP PC **A04**/MF **A01**
California Univ Los Angeles Western Management Science Inst
Design and Implementation of Large Scale Primal Transshipment Algorithms
Gordon H. Bradley, and Gerald G. Brown. 1975, 60p Rept no. WMSI Working Paper-260
Contract N00014-75-C-0570

Descriptors: *Algorithms, Optimization, Cost models, Mathematical programming, Linear programming, Computer programs.
Identifiers: *Network flows.

A complete description is given of the design, implementation and use of a family of very fast and efficient large scale minimum cost primal network programs. Choice of data structures and computational testing of the network system GNET are discussed. Important extensions are explained such as exploitation of special problem structure, element generation techniques, post optimality analysis, operation with problem generators and external problem files, and generalization beyond pure network models. (Author)

AD-A038 827/2CP PC **A06**/MF **A01**
California Univ Berkeley Electronics Research Lab
Bibliography on Numerical Software
Bo Einarsson. 25 Mar 77, 125p Rept no. UCB/ERL-M77/19
Contract N00014-76-C-0013

Descriptors: *Computer program documentation, *Computer programs, *Numerical methods and procedures, *Bibliographies, FORTRAN, Libraries, Differential equations, Integral equations, Linear algebra, Computer programming, Subroutines.
Identifiers: *Computer software, Structured programming.

This bibliography has been written at the request of the IFIP Working Group on Numerical Software (IFIP WG 2.5), and is intended to serve both members of the working group and others intent on improving numerical software. It has been divided into twenty-one different areas. Within each area the references are given in alphabetical order by the first author. Some references occur in two or at most three areas. This is especially true for the individual articles in the books of Section 2. For some entries a summary is included; either the original abstract, or a shortened form of the original, or a summary written by the present author. The aim of the bibliography is to be useful in the production and evaluation of good software for numerical mathematics. However, it does not include references to algorithms in the numerical analysis literature, nor does it include references to individual software products (routines). Section 7 on bibliographies includes many entries not strictly within the scope of the present work.

AD-A038 876/9CP PC **A05**/MF **A01**
David W Taylor Naval Ship Research and Development Center Bethesda Md
G-Prime B-Spline Manipulation Package Basic Mathematical Subroutines
Final rept.
James M. McKee, and Richard J. Kazden. Apr 77, 93p Rept no. DTNSRDC-77-0036

Descriptors: *Splines(Geometry), *Subroutines, Least squares method, Curves(Geometry), Surfaces, Computer programs, Computerized simulation, Programming languages.
Identifiers: *B-splines.

This report describes a library of mathematical subroutines for defining and operating on B-spline curves and surfaces. This library contains subroutines for evaluating B-spline functions, for using B-splines as a basis for fitting curves and surface data, and for finding the intersections of B-spline curves and surfaces. An explanation of the general theory, a summary of important properties, and detailed operating instructions for each subroutine are given. A program illustrating a typical use of the basic subroutines has been included along with computer-generated plots of B-spline surfaces and intersection curves. Although the basic evaluation subroutines use previously published techniques, the fitting and intersection procedures represent effective new approaches to the treatment of these old problems. (Author)

AD-A038 940/3CP PC **A03**/MF **A01**
Wisconsin Univ Madison Mathematics Research Center
Computational Aspects of Optimal Recovery
Technical summary rept.
Carl De Boor. Dec 76, 26p Rept no. MRC-TSR-1706
Contract DAAG29-75-C-0024

Descriptors: *Functional analysis, Recovery, Optimization, Linear systems, Splines(Geometry), Interpolation, Computations, Computer programs, Fortran, Envelope(Space).

This paper offers a Fortran program for the calculation of the recovery scheme which recovers a function from its values at certain data points in an optimal way. A short derivation of that recovery scheme is given first, as well as a derivation of the related envelope construction. The underlying computational problem: to construct an extension with prescribed norm of a linear functional of some finite dimensional linear subspace to all of L sub 1(a,b).

AD-A038 963/5CP PC **A02**/MF **A01**
Wisconsin Univ Madison Mathematics Research Center
Software for Interval Arithmetic: A Reasonably Portable Package
Technical summary rept.
J. M. Yohe. Mar 77, 25p Rept no. MRC-TSR-1731
Contract DAAG29-75-C-0024

Descriptors: *Computer program documentation, *Arithmetic, Computer architecture, Fortran, Compilers, Subroutines, Variables, Formats, Computer programs.
Identifiers: *Computer software, *Interval arithmetic, Precompilers, *Computation.

One means of bounding the error in digital computation is through the use of interval, or range, arithmetic; instead of computing with approximate real numbers, one calculates with pairs of approximate real numbers -- the first member of a pair being a lower bound for the true result, and the second an upper bound. By this method, one can take into account such varied sources of error as uncertainty in input data, inaccuracies in mathematical formulae, and errors in approximation of real numbers and the operations on them. The theory of interval arithmetic is developed extensively elsewhere. The major obstacle to the use of interval arithmetic is the unavailability of software. Interval is not a standard data type in any production language that we know of; preparation of a package of subprograms to handle interval data is a nontrivial task.

AD-A038 964/3CP PC **A03**/MF **A01**
Wisconsin Univ Madison Mathematics Research Center
A Fortran-Triplex-Pre-Compiler Based on the Augment Pre-Compiler
Technical summary rept.
K. Boehmer, and R. T. Jackson. Mar 77, 34p Rept no. MRC-TSR-1732
Contract DAAG29-75-C-0024

Descriptors: *Compilers, Fortran, Arithmetic, Computer programs, Variables, Intervals, Errors, Subroutines.
Identifiers: *Precompliers, Triplex arithmetic, Interval arithmetic.

Triplex arithmetic is a variation of interval arithmetic in which a main or rounded value is computed in addition to the end-points of the containing interval. The main value may be considered, depending on the application, to be the most probable result of the computation, with the interval bounds indicating the possible error. This paper describes an implementation of Triplex arithmetic in single and multiple precision. The implementation is based on the Augment precompiler to obtain an easily used package. (Author)

AD-A039 094/8CP PC **A06**/MF **A01**
New Jersey Inst of Tech Newark
A Fast Boundary Tracking Algorithm for Constrained Nonlinear Mathematical Programming Problems
Interim rept.
Jacob Moradi, and Michael Pappas. Mar 77, 119p Rept no. NJIT-NV-12
Contract N00014-75-C-0987

Descriptors: *Nonlinear programming, Structural engineering, Computer aided design, Algorithms, Search theory, Structural response, Boundaries, Flow charting, Computer programs, Machine coding.

A fast search algorithm for the solution of nonlinear mathematical programming optimization prob-

lems is presented in this report. The procedure combines a boundary tracking (BT) strategy with the feasible direction finding method of zoutendijk. This algorithm was compared with twenty other codes representing most of the popular numerical optimization methods on ten test problems. The new code proved superior to all others in overall generality and efficiency.

AD-A039 394/2CP PC **A05**/MF **A01**
University Coll Cork (Ireland) Dept of Mathematical Physics
Fundamentals of the Edge-Function Method via Laplace's Equation
Scientific interim rept. 1 Jul 75-30 Jun 76
Patrick M. Quinlan. 1 Feb 77, 88p EOARD-TR-77-01
Grant AF-AFOSR-2786-75
Includes envelope with Appendices A (1), A (2), B(1) and B (2).

Descriptors: *Boundary value problems, *Linear differential equations, Fourier analysis, Heat transfer, Heat flux, Edges, Boundaries, Curve fitting, Harmonic analysis, Polygons, Cavities, Computer applications, Computer programs.
Identifiers: Laplace equation, Ireland.

The main algebraic and programming features of the Edge-Function Method are illustrated by application to Laplace's equation for polygonal regions with elliptical cavities. The basic functions, vertex, edge and mapped polars, are obtained. Vertex Functions, Harmonic Fitting and submission into elements are covered. Programs are attached. (Author)

AD-A039 554/1CP MF **A01**
Navy Underwater Sound Lab New London Conn
Weighted Linear Regression for Two Variables
Technical memo.
John Skory, and Robert C. Jennings. 11 Dec 69, 51p Rept no. NUSL-TM-2070-451-69
Availability: Microfiche copies only.

Descriptors: *Linear regression analyses, *Programming manuals, Weighting functions, Variables, Signal processing, Estimates, Confidence limits, Tolerance, Analysis of variance, Computer programs.
Identifiers: Most project-3.

The primary purpose of linear regression is the prediction of Y from a given value of X by means of the regression equation Y=BX or Y=A+BX, and the estimation of confidence limits for true Y, A and B. Regression analysis for two variables may be made on a weighted or unweighted basis with the line passing through the origin or through the means.

AD-A039 951/9CP PC **A03**/MF **A01**
Naval Postgraduate School Monterey Calif
Determination of Hypothesis Testability in Linear Statistical Models
Master's thesis
William Hammond Walls. Mar 77, 50p

Descriptors: *Analysis of variance, *Mathematical models, Linear systems, Test methods, Statistical tests, Hypotheses, Computer applications, Estimates, Inverse problems, Computer programs, Theses.
Identifiers: Constraints.

Analysts conducting experiments must frequently deal with situations in which data is incomplete or missing. This creates problems that can seriously affect classical hypothesis testing by introducing extraneous terms into the hypothesis in a complicated way. A technique exists that allows an analyst to determine precisely which experimental terms are actually present in a proposed hypothesis and what that hypothesis would actually be testing if employed. This paper examines the mathematics underlying the technique and applies the theory to a widely used data analysis computer package. A computer program is presented to facilitate implementation of the method. (Author)

AD-A040 199/2CP PC **A05**/MF **A01**
Naval Postgraduate School Monterey Calif
Comparison of Log-Gamma and Lieberman-Ross Lower Confidence Limit Procedures on System Reliability
Master's thesis
Teddy Ray Maynard. Mar 77, 96p

Descriptors: *Systems analysis, *Confidence limits, Reliability, Computerized simulation, Accuracy, Modification, Methodology, Analysis of variance, Random variables, Sampling, Computer programs, Theses.
Identifiers: Lieberman-Ross method.

This thesis is an accuracy study of three empirical series system lower confidence limit procedures. Computer simulations were used to compare the accuracy of the procedures using the same set of data with 500 replications for each case. Modifications were then made to improve the accuracy of the Log-Gamma method. The systems simulated had reliabilities ranging from .6 to .95. They were composed of four, fifteen, or forty components and had component sample sizes of ten, twenty, or fifty. The Lieberman-Ross method was accurate but had high variance. The Log-Gamma method was conservative with small sample sizes, but became more accurate with increased testing. Randomization of the Log-Gamma method was the most successful of the modifications attempted. (Author)

AD-A040 378/2CP PC **A12**/MF **A01**
Arcon Corp Wakefield Mass
Interactive Math Modeling
Final rept. 1 Oct 73-1 Sep 76
Stanley Woolf, John V. O'Brien, Edward Cohen, David Baker, and Jean Hsiung. Feb 77, 270p
RADC-TR-77-86
Contract F19628-74-C-0049

Descriptors: *Mathematical models, *Statistical analysis, *Signal processing, Harmonic analysis, Gravity waves, Correlation techniques, Electron transport, Monte Carlo method, Boltzmann equation, Radar, Simulation, Speech, Surface waves, Acoustic waves, Loran, Integral equations, Computer programs, Filter analysis, Digital systems, Iterations.

Techniques and computer programs developed to analyze various problems are described. The scope of the work extended into a vareity of technical areas. A program was written to design a filter for analog-to-digital converted radar signals. The problem of low energy electron transport in irradiated solids was studied via independent approaches, including: (1) an orders-of-scattering invarant imbedding calculation of transmitted and reflected scattered particle currents; (2) an iterative numerical solution for the one-dimensional Boltzmann equation for isotropic scattering.

AD-A040 698/3CP PC **A03**/MF **A01**
Massachusetts Inst of Tech Cambridge Lab for Computer Science
Finding Minimum Cutsets in Reducible Graphs
Adi Shamir. Jun 77, 30p Rept no. MIT/LCS/TM-85
Contract N00014-76-C-0366

Descriptors: *Network flows, Graphs, Computer programs, Algorithms, Paths, Theorems, Flow charting.
Identifiers: *Graph theory.

The analysis of many processes modelled by directed graphs requires the selection of a subject of vertices which cut all the cycles in the graph. Reducing the size of such a cutset usually leads to a simpler and more efficient analysis, but the problem of finding minimum cutsets in general directed graphs is known to be NP-complete. In this paper it is shown that in reducible graphs(and thus in almost all the practical flowcharts of programs), minmum cutsets can be found in linear time. An immediate application of this result is in program verification systems based on Floyd's inductive assertions method. (Author)

AD-A040 925/0CP MF **A01**
Royal Aircraft Establishment Farnborough (England)
A Fortran Subroutine to Solve the Two-Point Boundary Value Problem
Technical memo.
L. J. Richards. Jan 77, 22p RAE-TM-Math-7701, DRIC-BR-56405
Availability: Microfiche copies only.

Descriptors: *Computer programs, *Boundary value problems, Nonlinear differential equations, Fortran, Subroutines, Finite difference theory, Great Britain.
Identifiers: Newton method, *Two point boundary value problems.

This Memorandum describes a Fortran subroutine, BOVA, which provides the solution of a set of nonlinear ordinary differential equations subject to non-mixed two-point boundary value conditions. A finite difference method is used, together with newton's method. A specification and listing of the subroutine is given. (Author)

AD-A041 009/2CP PC **A03**/MF **A01**
Darcom Intern Training Center Texarkana Tex
Efficiency of the Misra-Fair Algorithm for the Solution of the Traveling-Salesman Problem
Final rept.
Walter E. Smythe. Apr 76, 36p Rept no. DARCOM-ITC-02-08-76-021

Descriptors: *Mathematical programming, Algorithms, Optimization, Routing, Computer programs, Integer programming, Mathematical logic.
Identifiers: *Traveling salesman problem, Branch and bound method, Misra-Fair algorithm, Fortran.

The efficiency of the Misra-Fair algorithm for solution of the Traveling-Salesman problem is investigated. A FORTRAN language computer program is written for the Misra-Fair algorithm, Little et al.'s Branch-and-Bound algorithm and the Closest-Unvisited-City algorithm. The accuracy and speed of solution of the programs using the Misra-Fair algorithm is compared to the accuracy and speed of solution of the programs using the Branch-and-Bound algorithm and the Closest-Unvisited-City algorithm. Preliminary computational results and suggestions for improving the computer program are given. (Author)

AD-A041 090/2CP PC **A02**/MF **A01**
Minnesota Univ Minneapolis Dept of Psychology
A Rapid Item-Search Procedure for Bayesian Adaptive Testing
Research rept.
C. David Vale, and David J. Weiss. May 77, 17p
Rept no. RR-77-4
Contract N00014-76-C-0243

Descriptors: *Search theory, Adaptive systems, Bayes theorem, Computer applications, Sequential analysis, Test methods, Minicomputers, Computer programs, Efficiency, Computerized simulation, Estimates.
Identifiers: Branched testing, Run time, Psychometric methods.

An alternative item-selection procedure for use with Owen's Bayesian adaptive testing strategy is proposed. This procedure is, by design, faster than Owen's original procedure because it searches only part (as compared with all) of the total item pool. Item selections are, however, identical for both methods. After a conceptual development of the rapid-search procedure, the supporting mathematics are presented. In a simulated comparison with three item pools, the rapid-search procedure required as little as one-tenth the computer time as Owen's technique. (Author)

AD-A041 178/5CP PC **A06**/MF **A01**
Naval Postgraduate School Monterey Calif
An Application of CP/CMS to the Time Series Analysis
Master's thesis
Young Woo Lee. Mar 77, 111p

Descriptors: *Time series analysis, *Computer programming, Time sharing, Editing, Computer

programs, User needs, Man computer interface, Statistical processes, Forecasting, Input output processing, Theses.

An interactive package of computer programs has been developed for the anlaysis of time series data. The package, called the Time Series Editor, is designed around the Box-Junkins' statistical methodology of time series analysis. The Time Series Editor was developed for time-shared use on the Controlled Program/Cambridge Monitor System (CP/CMS) but could be easily modified to accommodate other time-sharing systems. The Time Series Editor assists in data preparation, entry, analysis and diagnostic testing. Utilization of the package requires only a limited knowledge of the computer system with all required user responses prompted by the Editor. (Author)

AD-A041 538/0CP PC **A02**/MF **A01**
Rochester Univ N Y Dept of Statistics
A Simple Test for Normality
Interim rept.
Govind S. Mudholkar, and Chin-Chuong Lin.
1977, 18p AFOSR-TR-77-0769
Grant AF-AFOSR-3360-77

Descriptors: *Statistical tests, *Normalizing(Statistics), Sampling, Mean, Analysis of variance, Correlation techniques, Assessment, Bivariate density functions, Computer programs.
Identifiers: *Normality.

The mean and the variance of a random sample are independently distributed if and only if the parent population is normal. This characterization is used as a basis for developing a test termed Z-test for the composite hypothesis of normality. The simplicity of Z-test results from the computational ease and the clean form of the finite sample null distribution of the test statistic Z. It compares reasonably in power with several well known tests of normality and is particularly suitable for a joint assessment of normality. A routine for computing the statistic and its P-value is given. (Author)

AD-A042 286/5CP PC **A02**/MF **A01**
George Washington Univ Washington D C Program in Logistics
Solving Inventory Problems using the Factorable Nonlinear Programming Language
Scientific rept.
Garth P. McCormick. 1 Jun 77, 17p Rept no. Serial-T-357
Contract N00014-75-C-0729

Descriptors: *Programming languages, *Inventory analysis, *Nonlinear programming, Computer programs, Mathematical models, Optimization, Algorithms, Logistics.

This memorandum is intended to aid the logistics practitioner in setting up his algebraic statement of an optimization model in such a way that it can be automatically processed and solved by a canned nonlinear programming algorithm. The example used is the Schrady-Choe optimal inventory model. The model algorithm interface is accomplished by a new version of the factorable nonlinear programming language which allows for symbolic input. (Author)

AD-A042 524/9CP PC **A03**/MF **A01**
Army Concepts Analysis Agency Bethesda Md
An Analysis of Variance Program for 2 to the n-th Power and 3 to the n-th power Factorial Experiments
Carl B. Bates, and Jerry Thomas. Jul 77, 32p Rept no. CAA-D-77-2

Descriptors: *Analysis of variance, *Factorial design, *Computer programs, Arithmetic, Fortran, Computer program documentation.
Identifiers: *MOD-ANOVA computer program, Modular arithmetic, Univac 1108 computers.

Modulo Analysis of Variance (MOD-ANOVA) is a computer program for 2 to the n-th power and 3 to the n-th power full or fractional factorial experiments. The program applies modular arithmetic to cell identification numbers to classify and sum the observations. MOD-ANOVA is fast and efficient and is extremely simple in structure. The complete program contains less than 130 lines of code. The program is written in FORTRAN V and is operational on the UNIVAC 1108 computer, but it should be transferable to any computer compatible with FORTRAN.

AD-A042 711/2CP PC **A02**/MF **A01**
Communications Research Centre Ottawa (Ontario)
A Review of Maximum-Entropy Spectral Analysis
Technical note
R. W. Herring. May 77, 21p CRC-TN-685, DRB-TELS-TN-31

Descriptors: *Power spectra, *Time series analysis, Spectrum analysis, Entropy, Literature surveys, Derivatives(Mathematics), Subroutines, Computer programs, Computations, Spectral lines, Spikes, Peak values, Algorithms, Complex variables, Apertures, Antenna arrays, Angle of arrival, Canada.
Identifiers: *Maximum entropy method, Fortran.

The maximum-entropy method (MEM) of spectral analysis is a technique for estimating the power spectra of time-series data. The purpose of this note is to survey the literature of the MEM and to provide some insight into its derivation and usage. Fortran subroutines for computing the MEM power spectra of complex-valued data are included. (Author)

AD-A042 807/8CP MF **A01**
David W Taylor Naval Ship Research and Development Center Bethesda Md
CSKYTI: An Out-of-Core Cholesky Algorithm Equation Solver (with Respect to Profile) for the Texas Instruments' Advanced Scientific Computer
Research and development rept.
Donald A. Gignac. Jul 77, 25p Rept no. DTNSRDC-77-0082
Availability: Microfiche copies only.

Descriptors: *Matrices(Mathematics), *Linear algebraic equations, *Computer programming, Algorithms, Solutions(General), Computations, Precision, FORTRAN, Digital computers, Computer programs.
Identifiers: CDC 6600 computers, Cholesky algorithm, *CSKYTI computer program, Preprocessors.

CSKYTI is an out-of-core profile approach Cholesky algorithm equation solver for large sparse positive definite systems of linear equations. CSKYTI is an adaptation of an existing CDC 6000 series program, CSKYDG2, for the Advanced Scientific Computer (ASC 6). The preprocessor program SETUP for CSKYTI was similarly obtained from CSKYDG2's SETUP program. This report documents a comparison of the performance of CSKYTI and its SETUP on the ASC 6 with that of CSKYDG2 and its SETUP on the CDC 6600 at DTNSRDC. It would appear that the ASC 6 requires double precision arithmetic to obtain the significance of single precision computation on the CDC 6600. Even so, the ASC 6 was found to be fast compared to the CDC 6600. (Author)

AD-A043 122/1CP PC **A02**/MF **A01**
Ballistic Research Labs Aberdeen Proving Ground Md
Comments on the Solution Coupled Stiff Differential Equations
Final rept.
M. D. Kregel, and J. M. Heimerl. Jul 77, 17p Rept no. BRL-MR-2769
See also Rept. no. BRL-1733, AD-A003 855.

Descriptors: *Differential equations, Coupling(Interaction), Numerical analysis, Matrices(Mathematics), Solutions(General), Computer programs, Algorithms, Mathematical prediction, Error analysis, Truncation, Chemical reactions, Ionosphere.
Identifiers: *Stiff differential equations, K matrix, Numerical integration.

The K-method of integrating sets of ordinary differential equations is outlined. This algorithm employs a variable step size, third order predictor-corrector method. It is written to reduce truncation error and to maximize stability consistent with reasonable execution time. The K-method has been used to integrate equations with discontinuous driving functions and this algorithm conserves chemical balance within the machine round-off error. It has been applied to solve kinetics problems in aeronomy and examples are taken from that field. (Author)

AD-A043 180/9CP PC **A02**/MF **A01**
Navy Experimental Diving Unit Panama City Fla
Analysis of Multivariate Data: A Computer Program
Final rept.
Robert C. Carter, Jr. 25 Mar 77, 20p Rept no. NEDU-2-77

Descriptors: *Computer programs, *Multivariate analysis, *Analysis of variance, Sampling, Statistical analysis, Regulators, Scuba apparatus, Man computer interface, Display systems, Data processing, Methodology, Flow charting.

A computer program is presented which calculates multivariate analyses of variance. The method used in the program is described, and an application of program is illustrated. The method is appropriate when several variables are measured in each of several samples, and it is hypothesized that the average of each variable is the same in all samples. (Author)

AD-A043 362/3CP PC **A05**/MF **A01**
Stanford Univ Calif Dept of Computer Science
Complexity of Combinatorial Algorithms
Technical rept.
Robert E. Tarjan. Apr 77, 87p Rept no. STAN-CS-77-609
Contract N00014-76-C-0668, Grant NSF-MCS-75-22870

Descriptors: *Combinatorial analysis, *Computer programming, Algorithms, Mathematical models, Problem solving, Computer program verification, Efficiency, Random access computer storage, Decision theory, Heuristic methods, Time.
Identifiers: Computational complexity, Trees(Mathematics).

This paper examines recent work on the complexity of combinatorial algorithms, highlighting the aims of the work, the mathematical tools used, and the important results. Included are sections discussing ways to measure the complexity of an algorithm, methods for proving that certain problems are very hard to solve, tools useful in the design of good algorithms, and recent improvements in algorithms for solving ten representative problems. The final section suggests some directions for future research. (Author)

AD-A043 438/1CP PC **A03**/MF **A01**
Naval Research Lab Washington D C
Solution of the Perturbed Harmonic Oscillator by Computer
Final rept.
K. T. Alfriend , and H. M. Pickard. May 77, 30p Rept no. NRL-MR-3513

Descriptors: *Nonlinear differential equations, *Computer programs, Solutions(General), Oscillators, Harmonics, Perturbations, Series(Mathematics), Computer programming, FORTRAN.
Identifiers: Harmonic oscillators.

A FORTRAN program has been developed for solving non-linear differential equations of the form $dX/d+X+epsilon\ f(X;epsilon) = 0$ using Lindstedt's method. This method provides a uniformly valid series solution by introducing a transformation in the time variable via a scale factor which is a power series in the small parameter epsilon. Secular terms which cause non-uniformity may be then constrained to disappear. The details of the method are carried out using an algebraic manipulation package. The use of the computer program is discussed and examples are supplied. (Author)

AD-A043 459/7CP PC **A05**/MF **A01**
PRC Information Sciences Co Mclean Va
Preliminary Functional Design for the Events Diagnostics System
Final technical rept. 13 May 76-13 Feb 77
Timothy J. Delanty, Hawley A. Blanchard, Pauline M. Ippolito, Steven A. Soechtig, and Jack E. Pevenstein. Jul 77, 77p PRC-R-2014, RADC-TR-77-235
Contract F30602-76-C-0267

Descriptors: *Forecasting, *Computer aided diagnosis, *Computer programs, Classification, Political science, Military strategy, Predictions, Classification, Probability, Statistics, Message processing, Machine coding, Display systems, Warning systems, Indicators.
Identifiers: *Events Diagnostics System.

This report describes the preliminary functional design for The Events Diagnostics System (TEDS). TEDS has evolved from a series of studies begun in 1972 focused on computer assisted ways by which an Indications and Warning (I and W) analyst may be helped to draw inferences concerning the likelihood occurrences of noteworthy and significant military-political events. TEDS features an event classification structure consisting of 26 military, political, diplomatic and economic event classes. Each event class consists of a number of 'a priori' indicators as selected from official literature, historical analysis and expert testimony. When these indicators are matched with an 'a posteriori' incident report, TEDS performs its processing functions and generates the several diagnostic displays for use by the analyst. Periodic multiple regression analyses are performed with the aid of the analyst and after-the-fact event evaluation to adjust the model by specific indicator and event class, thus providing for systematic feedback and improvement.

AD-A043 733/5CP PC **A04**/MF **A01**
Frank J Seiler Research Lab United States Air Force Academy Colo
A Study of Tunable Integration and Control Theory for the Analysis of Differential Equation Solvers
Final rept. Jan 75-Dec 76
Marc L. Sabin. May 77, 75p Rept no. FJSRL-TR-77-0006

Descriptors: *Differential equations, *Numerical methods and procedures, *Control theory, Integrators(Computers), Solutions(General), Linearity, Stability, Frequency response, Error analysis, Numerical analysis, Computer applications, Machine coding, Computer programs, Truncation.

Tunable integration is an approach to the numerical solution of ordinary differential equations that is conceived, developed, and employed based upon the principles of linear control theory. The properties of the zero-order-hold tunable integrator and the control-theory methods used to analyze those properties are equally important in the context of this report. Beginning with a discussion of numerical error from a control-theory perspective, the concept is presented of an ideal integrator having no error but that due to finite computer word length. The lack of adaptability of the ideal integrator motivates the tunable integrator, which possesses the requisite flexibility. The majority of the report covers the analytic development of tunable integration, the frequency response of the zero-order-hold tunable integrator, and a root-locus analysis of that integrator as employed in a first-order, linear system. Throughout the presentation, emphasis is placed on the use of these control-theory techniques to determine stability and to tune the integrator for improved performance.

AD-A043 783/0CP PC **A03**/MF **A01**
Ballistic Research Labs Aberdeen Proving Ground Md
Estimation of Precision of Measurement and Product Variability: A Computer Model
Memorandum rept.
James F. O'Bryon. Aug 77, 36p Rept no. BRL-MR-2778

Descriptors: *Measurement, *Analysis of variance, *Computer programs, Precision, Multiple operation, Comparison, Variations, Bias, Instrumentation, Data reduction, Probability density functions.
Identifiers: Outliers, Fortran 4 programming language.

When two or more instruments are used to simultaneously measure the same phenomena, it is possible, with a few assumptions, to obtain the most efficient unbiased estimator for the precision of measurement of each instrument as well as an estimation of the true variability of the event being observed. A computer program written in FORTRAN IV which performs these calculations is presented and discussed. Up to 10 instruments taking simultaneous measurements can be handled for a series of up to 50 observations per instrument. Provision is also made to determine whether any given instrument is performing significantly different statistically from other instruments measuring simultaneously. Sample examples are also included to illustrate the program's usage and flexibility. (Author)

AD-A043 867/1CP PC **A04**/MF **A01**
Joint Conventional Ammunition Program Coordinating Group Rock Island Il Decision Models Directorate
Priorities Modeling using Goal Growth Programming
Final rept. 1976-1977
Daniel R. Turk. Aug 77, 68p Rept no. JCAP-DM-T701

Descriptors: *Goal programming, *Decision making, Mathematical models, Computer programming, Integer programming, Computer programs, Scheduling, Cost analysis, Management planning and control, Budgets, Trade off analyses, FORTRAN.
Identifiers: Zero base budgeting.

The JCAP Priorities Model is a group of programs which evaluates and orders decision alternatives, such as various schedules of projects, for maximum planned growth to multiple goals in accordance with goals and priorities established by the manager himself or by higher authority. The purpose is stated simply as to develop and rank decision alternatives for maximum achievement of overall management goals, both economic and non-economic. The model answers questions of how, when, where and in what amounts should resources be allocated to competing options in situations where multiple objectives prevail. The Priorities Model, in achieving this objective, utilizes new technique -- GOAL GROWTH PROGRAMMING -- to develop target goal growth paths that reflect both short-range and long-range management priorities. The model then resolves the trade-offs involved so that the final solution does represent the best attainable goal growth plan from among the many combinations of alternatives available.

AD-A043 997/6CP PC **A09**/MF **A01**
Naval Surface Weapons Center Dahlgren Lab VA
Computation of the Percentage Points of the Chi-square Distribution
A. R. DiDonato, and R. K. Hageman. Apr 77, 191p Rept no. NSWC/DL-TR-3569

Descriptors: *Computer programming, Chi square test, Computations, Statistical distributions, Functions(Mathematics), Numerical integration, Iterations, Computer programs, FORTRAN.
Identifiers: Newton-Raphson method, Percentage points, Gamma functions, Fortran 4 programming language.

A Fortran IV program is developed for computing the percentage points of the Chi-square distribution. The Newton-Raphson procedure is used with good initial approximations. The maximum number of iterations is four and in most cases only one or two are needed. An extensive table is given of the percentage points Chi squared in terms of nu, a positive number, and Q(nu/Chi squared), the probability integral of the Chi-square distribution. (Author)

AD-A044 040/4CP PC **A08**/MF **A01**
Analytical Systems Engineering Corp Burlington Mass
Mathematical Analysis and Implementing Software for Physical and Engineering Data
Final rept. 27 Apr 76-26 Apr 77
Edward Ziemba, Andre Lacroix, Muriel Hervey, John Crosby, and Joanna Enzmann . May 77, 159p AFGL-TR-77-0116
Contract F19628-76-C-0203

Descriptors: *Computer programming, Mathematical analysis, Data processing, Data reduction, Computer programs, Numerical analysis, Ionospheric scintillations, Mapping, Aerosols, Spectroscopy, Radar correlation, Meteorological data, Ephemerides, Meteorological satellites.

The purpose of this report is to describe most of the numerical analysis, data analysis and computer programming problems performed under this contract. The problems vary in complexity from straightforward program adaptation to tasks requiring analysis, determining, implementing, and sometimes deriving algorithm best suited to perform the calculations. The problems discussed are done so in summary form. The analysis and programming techniques required are outlined. It should be noted that some of these problems are still being analyzed because of their complexity or continuing nature. Others are active because they were begun shortly before the writing of this report. (Author)

AD-A044 118/8CP PC **A04**/MF **A01**
Texas Univ At Austin Center for Cybernetic Studies
A Computational Analysis of Alternative Algorithms and Labeling Techniques for Finding Shortest Path Trees
Research rept.
Robert Dial, Fred Glover, David Karney, and Darwin Klingman. Apr 77, 64p Rept no. CCS-291
Contract N00014-75-C-0569, N00014-75-C-0616
Prepared in cooperation with Analysis, Research and Computation, Inc., Austin, TX, contract DOT-UT-60054.

Descriptors: *Networks, *Linear programming, Computer programming, Labels, Algorithms, Computer programs, Nodes, Time.
Identifiers: *Shortest route problem, Shortest path method.

This paper examines different algorithms for calculating the shortest path from one node to all other nodes in a network. More sepcifically, the authors seek to advance the state-of-the-art of computer implementation technology for such algorithms and the problems they solve by examining the effect of innovative computer science list structures and labeling techniques on algorithmic performance. The study shows that the procedures examined indeed exert a powerful influence on solution efficiency, with identity of the best dependent upon the topology of the network and the range of the arc distance coefficients. The study further disclose that the shortest path algorithm previously documented as the most efficient is dominated for all problems structures by the new methods, which are sometimes an order of magnitude faster. (Author)

AD-A044 344/0CP PC **A03**/MF **A01**
Army Engineer Waterways Experiment Station Vicksburg Miss
Application of Spline Interpolation Methods to Engineering Problems
Final rept.
James B. Cheek, Jr, Narayanaswamy Radhakrishnan, and Fred T. Tracy. Jul 71, 40p Rept no. WES-MP-8-71-2

Descriptors: *Cubic spline technique, *Curve fitting, *Computer programming, Interpolation, Engineering, Problem solving, Computer programs, Methodology, Seepage, Weirs, Construction, FORTRAN.
Identifiers: *Spline interpolation.

This paper was prepared to familiarize practicing scientists and engineers with the cubic spline interpolation technique as a possible tool in curve fitting for computer programs for which more commonly used techniques may be unsuitable or of limited value. The spline technique is compared with more common methods, specifically

piecewise linear and polynomial, and examples of applications of the technique to engineering problems are presented.

AD-A044 736/7CP PC **A05**/MF **A01**
Texas Univ At Austin Center for Numerical Analysis
Extrapolation with Spline-Collocation Methods for Two-Point Boundary-Value Problems II: C2-Cubics with Detailed Results
James W. Daniel, and Andrew J. Martin. Aug 77, 77p Rept no. CNA-125
Contract N00014-76-C-0275

Descriptors: *Cubic spline technique, *Boundary value problems, Extrapolation, Splines(Geometry), Numerical analysis, Differential equations, Solutions(General), Finite difference theory, Corrections, Computer programs.
Identifiers: *Two point boundary value problems, Collocation method.

The methodology is very briefly described and then numerical results are presented for an implementation of a smooth-cubic-spline-collocation procedure accelerated via iterated deferred corrections to obtain approximate solutions, accurate to a prescribed tolerance, of two-point boundary-value problems for second-order scalar ordinary differential equations. The results are similar to those obtained via a less generally applicable finite-difference-oriented code described elsewhere which competes well with the best codes available. (Author)

AD-A044 760/7CP PC **A05**/MF **A01**
Alfred P Sloan School of Management Cambridge Mass Center for Information Systems Research
Set Decomposition: Cluster Analysis and Graph Decomposition Techniques
Technical rept.
Rafael C. Andreu. Sep 77, 86p Rept nos. CISR-P010-01-01, CISR-TR-1
Contract N00039-77-C-0255

Descriptors: *Set theory, *Decomposition, *Clustering, Computer programs, Experimental design, Graphics, Systems approach, Algorithms, Heuristic methods.
Identifiers: *Cluster analysis.

The investigation of a systematic approach for the early phases of the system development process generates the problem of decomposing a given set in which interdependencies have been defined among its elements, so as to obtain a collection of subsets as free of interdependencies as possible. This problem is analyzed and solutions proposed; cluster analysis and graph decomposition techniques are applied and shown to possess some similarities which allow to approach set decomposition problems within a unified framework. (Author)

AD-A044 906/6CP PC **A07**/MF **A01**
Stanford Univ Calif Systems Optimization Lab
MINOS. A Large-Scale Nonlinear Programming System (For Problems With Linear Constraints). User's Guide
Technical rept.
Bruce A. Murtagh, and Michael A. Saunders. Feb 77, 132p Rept no. SOL-77-9
Contract N00014-75-C-0865, EY-76-S-03-0326
Also prepared under Grants NSF-MCS-76-20019 and NSF-MCS-75-04544.

Descriptors: *Programming manuals, *Linear programming, *Nonlinear programming, *Computer programs, Optimization, Linear systems, Full scale systems, Subroutines, Solutions(General), Sparse matrix, Fortran, Algorithms, Simplex method.
Identifiers: Constraints, *MINOS computer program.

MINOS is a Fortran program designed to minimize a linear or nonlinear function subject to linear constraints, where the constraint matrix is in general assumed to be large and sparse. The User's Guide contains an overview of the MINOS System, including descriptions of the theoretical algorithms as well as the details of implementation. The Guide also provides complete instructions for the use of MINOS, and illustrates the diversity of application by several examples. (Author)

AD-A046 372/9CP PC **A05**/MF **A01**
Wisconsin Univ Madison Mathematics Research Center
The Interval Arithmetic Package
Technical summary rept.
J. M. Yohe. Jun 77, 88p Rept no. MRC-TSR-1755
Contract DAAG29-75-C-0024
Includes Change 1 dated Sep 77 and envelope with film.

Descriptors: *Computer program documentation, *Arithmetic, Computations, Intervals, User needs, Compatibility, Computers, Subroutines, Input output processing, Compilers, Fortran, Flow charting, Hierarchies.
Identifiers: Univac-1110 computers, DEC computers, IBM computers.

This report provides user documentation and technical documentation for a package of FORTRAN subroutines for performing interval arithmetic calculations. Apart from a relatively small number of primitives and constants, the package is directly transferrable to most large scale computing systems, and information for implementing the package on other systems is included. The implementation described herein is that for UNIVAC 1110, but the package has also been implemented on CDC, DEC, Honeywell, and IBM equipment. (Author)

AD-A046 377/8CP PC **A02**/MF **A01**
Wisconsin Univ Madison Mathematics Research Center
Solving a System of Linear Inequalities for Generating Test Data
Technical summary rept.
Bo Einarsson. Aug 77, 15p Rept no. MRC-TSR-1780
Contract DAAG29-75-C-0024

Descriptors: *Linear algebraic equations, *Inequalities, *Simplex method, Solutions(General), Linear programming, Data processing, Computer program verification, Test methods, Data transmission systems, Computer programming.

A simple inequality solver, based on the simplex method, for determining safe input data corresponding to execution of a certain path of a computer program, is presented. Special consideration is given the influence from rounding errors on the solution. (Author)

AD-A046 404/0CP PC **A02**/MF **A01**
Wharton School of Finance and Commerce Philadelphia Pa Dept of Decision Sciences
Description of the Wharton/ODA System
Final rept.
Nov 77, 11p Rept no. 77-11-02
Contract N00014-75-C-0440

Descriptors: *Decision making, *Computer applications, Operations research, Man computer interface, Computer programs, Data bases, Computer architecture, Data storage systems, Data processing equipment.
Identifiers: ARPA computer network.

The purpose of this document is to give a brief introduction to the hardware available in the Wharton Computer Center and the Decision Aiding Systems Laboratory (DASL), and to summarize the software which has been developed at Wharton under the OPERATIONAL Decision Aiding Project. More detail about most of these features is available; in particular, some of the other software developed for use on the Wharton system may be of interest to other contractors, now that the system is easily accessible via the ARPANET. (Author)

AD-A046 598/9CP MF **A01**
Colorado State Univ Fort Collins Dept of Mathematics
Adaptive Curve Fitting
Interim rept.
J. A. Hull, and G. D. Taylor. Jul 77, 47p AFOSR-TR-77-1257
Grant AFOSR-76-2878
Availability: Microfiche copies only.

Descriptors: *Curve fitting, *Data reduction, Adaptive systems, Algorithms, Machine coding, Computer applications, Fortran, Computer programs, Polynomials, Approximation(Mathematics), Operators(Mathematics), Numerical analysis.

This paper presents an algorithm for adaptively computing smooth piecewise polynomial approximations which uses either the best uniform or best (discrete) L(2) approximation operator as its local approximation operator. No knowledge of derivatives of the function being approximated is required. Due to the approximation properties of the respective operators, the algorithm found using best uniform approximations is particularly suited for approximating precise mathematical functions and the algorithm using best L(2) approximations is particularly suited for approximating data with significant levels of noise. Finally, this algorithm can be used with classes of approximating functions other than polynomials. Fortran codes for these two algorithms are given in the appendix at the end of this paper.

AD-A046 602/9CP PC **A03**/MF **A01**
Colorado State Univ Fort Collins Dept of Mathematics
Restricted Range Adaptive Curve Fitting
Interim rept.
J. A. Hull, and G. D. Taylor. Jul 77, 35p AFOSR-TR-77-1258
Grant AFOSR-76-2878

Descriptors: *Curve fitting, *Data reduction, Data processing, Approximation(Mathematics), Adaptive systems, Polynomials, Algorithms, Numerical methods and procedures, Machine coding, Fortran, Input, Computer programs.
Identifiers: Constraints.

This paper presents an algorithm for adaptively computing smooth piece-wise polynomial approximations using restricted range uniform approximations. Also several numerical examples are presented and suggestions offered for the effective use of this algorithm. The algorithm is found to be effective for approximating a wide class of functions, either with or without significant levels of noise. Furthermore, since the user of this algorithm actually defines tolerance bands within which the approximation will lie, the algorithm allows the user a great deal of flexibility and control over the shape of the resulting approximations. A Fortran code of this algorithm is included in an appendix at the end of the paper.

AD-A047 171/4CP PC **A05**/MF **A01**
Naval Postgraduate School Monterey Calif
A Comparative Accuracy of Several Discrete Methods for Lower Confidence Limit on System Reliability
Master's thesis
Sep 77, 85p

Descriptors: *Reliability, *Confidence limits, *Systems analysis, Computerized simulation, Analysis of variance, Bernoulli distribution, Computer programs, Theses.
Identifiers: Maximum likelihood estimation.

This thesis is a comparative accuracy study of several discrete methods for lower confidence limits on series system reliability. Computer simulations were used to compare the accuracy of the procedures. Five hundred replications were used in all simulations. Accuracy of each procedure was determined by computing appropriate percentile points of the distributions of the lower confidence limits. A randomization technique was used to improve the performance of one of the procedures. The systems simulated had reliabilities ranging from 0.720 to 0.950. They were composed of five, ten, thirteen, and fifteen components, and had component sample sizes of fifteen, thirty, fifty, and larger in the case of unequal sample sizes. Based on the simulation results the accuracy of the procedures were compared by common comparison with the true system reliabilities which were known in advance prior to the component tests. (Author)

AD-A047 243/1CP PC **A04**/MF **A01**
Rand Corp Santa Monica Calif
Feasibility of a Special-Purpose Computer to Solve the Navier-Stokes Equations
Interim rept.
E. C. Gritton, W. S. King, I. Sutherland, R. S. Gaines, and C. Gazley, Jr. Jun 77, 75p Rept no. R-2183-RC

Descriptors: *Hydrodynamics, *Numerical analysis, *Parallel processors, Computer applications, Boundary layer flow, Viscous flow, Equations of motion, Man computer interface, Computer architecture, Computer programs, Matrix theory, Data management.
Identifiers: *Navier-Stokes equations, *Computer calculations, Partial differential equations.

This report summarizes the feasibility of developing a special-purpose computer to solve the Navier-Stokes equations. The conclusions suggest that a special-purpose, parallel-processor machine capable of important fluid dynamics simulations might be technically and economically feasible in the early 1980 time period. The report presents a conceptual design for such a computer, an analysis of how it can be used to solve the Navier-Stokes equations, and performance estimates.

AD-A047 724/0CP PC **A03**/MF **A01**
Yale Univ New Haven Conn Dept of Computer Science
Yale Sparse Matrix Package. I. The Symmetric Codes
Research rept.
S. C. Eisenstat, M. C. Gursky, M. H. Schultz, and A. H. Sherman. Apr 77, 39p Rept no. RR-112
Contract N00014-76-C-0277, F49620-77-C-0037
Prepared in cooperation with California Univ., Berkeley. Dept. of Electrical Engineering and Computer Sciences and Texas Univ. at Austin. Dept. of Computer sciences. See also report dated Aug 77, AD-A047 725.

Descriptors: *Sparse matrix, *Computer programs, Solutions(General), Linear algebra, Decomposition, Machine coding, Symmetry, Data storage systems, Subroutines, Fortran.

Consider the NxN system of linear equations M x = b, where the coefficient matrix M is large, sparse, symmetric, and positive definite. Such systems arise frequently in scientific computation, e.g., in finite difference and finite element approximations to elliptic boundary value problems. This report presents a package of efficient, reliable, well-documented, and portable Fortran subroutines for solving these systems.

AD-A047 725/7CP PC **A04**/MF **A01**
Yale Univ New Haven Conn Dept of Computer Science
Yale Sparse Matrix Package. II. The Nonsymmetric Codes
Research rept.
S. C. Eisenstat, M. C. Gursky, M. H. Schultz, and A. H. Sherman. Aug 77, 62p Rept no. RR-114
Contract N00014-76-C-0277, F49620-77-C-0037
Prepared in cooperation with California Univ., Berkeley. Dept. of Electrical Engineering and Computer Sciences and Texas Univ. At Austin. Dept. of Computer Sciences. See also report dated Apr 77, AD-A047 724.

Descriptors: *Sparse matrix, *Computer programs, Solutions(General), Boundary value problems, Linear algebra, Decomposition, Machine coding, Asymmetry, Data storage systems, Subroutines, Fortran.

Consider the NxN system of linear equations M x = b, where the coefficient matrix M is large, sparse, and nonsymmetric. Assume that M can be factored in the form M = L D U, where L is a lower triangular matrix, D is a diagonal matrix, and U is a unit upper triangular matrix. Such systems arise frequently in scientific computation, e.g., in finite difference and finite element approximations to non-self-adjoint elliptic boundary value problems. This report presents a package of efficient, reliable, well-documented, and portable Fortran subroutines for solving these systems.

AD-A047 748/9CP PC **A05**/MF **A01**
Southern Methodist Univ Dallas Tex Dept of Statistics
A New Approach to ARMA Modeling
Technical rept.
H. L. Gray, G. D. Kelley, and D. D. McIntire. 1 Dec 77, 82p Rept no. TR-126
Contract N00014-75-C-0439

Descriptors: *Time series analysis, Mathematical prediction, Forecasting, Mathematical models, Simplification, Regression analysis, Self operation, Sampling, Estimates, Spectrum analysis, Algorithms, Computer programs.
Identifiers: Box-Jenkins method.

In recent years the Box-Jenkins method has become a popular technique for forecasting future behavior of a time series. Once the forecast model is known the method is very easy to employ and adequate computer packages are available for most purposes. Unfortunately the problem of determining the appropriate forecast model has, for models of any complexity, been one of the major stumbling blocks to the user of this method. In this paper a satisfactory solution to that problem is obtained and it is demonstrated by numerous examples how this greatly enlarges the class of data sets which can be adequately modeled by autoregressive-moving average models. This new approach is sufficiently unequivocal that most users will find it easy to implement. (Author)

AD-A048 035/0CP PC **A04**/MF **A01**
Naval Underwater Systems Center New London Conn New London Lab
Positive Definite Spectral Estimate and Stable Correlation Recursion for Multivariate Linear Predictive Spectral Analysis
Technical rept.
Albert H. Nuttall. 14 Nov 77, 51p Rept no. NUSC-TR-5729

Descriptors: *Spectrum analysis, *Recursive functions, *Multivariate analysis, Correlation techniques, Matrices(Mathematics), Linear systems, Fast fourier transforms, Fortran, Computer applications, Computer programs, Mathematical prediction.
Identifiers: Hermetian matrices.

The questions regarding a positive definite spectral estimate and a stable correlation recursion are answered in the affirmative for the particular choice of weighting recommended in the above reference. A modified and updated FORTRAN program for multivariate spectral analysis, which incorporates calculation of the correlation matrices via recursion, and the aliased correlation matrices via a fast Fourier transform (FFT), are included.

AD-A048 151/5CP PC **A03**/MF **A01**
Clemson Univ S C Dept of Mathematical Sciences
TSA: Statistical Programs for Interactive Time Series Analysis
K. T. Wallenius. 30 Sep 77, 49p Rept nos. N85, TR-268
Contract N00014-75-C-0451

Descriptors: *Time series analysis, *Computer programs, Interactive graphics, Transformations(Mathematics), Batch processing, Compilers, Input output processing, Stochastic control, Noise reduction, Mathematical filters.
Identifiers: Box-Jenkins filters, *TSA computer program, Statistical analysis.

This report is a description of TSA, an interactive package of computer programs designed to implement Box-Jenkins type of analysis of univariate time series. In addition to the usual features found in many similar packages, TSA offers training modules which facilitate learning the 'art' of successful time series analysis. (Author)

AD-A049 296/7CP PC **A03**/MF **A01**
Defence and Civil Inst of Environmental Medicine Downsview (Ontario)
A Technique for Calculating the Parameters of a Normal or Lognormal Cumulative Distribution
Technical rept.
R. Y. Nishi, and P. B. L. Giry. Oct 76, 31p Rept no. DCIEM-TR-76-X-71

Descriptors: *Normal distribution, *Biostatistics, *Computer programs, Logarithm functions, Mean, Standard deviation, Linear regression analyses, Calculators, FORTRAN, Flow charting, Blood platelets, Sizes(Dimensions).
Identifiers: *Lognormal density functions, Canada.

The statistical distribution of biological phenomena is generally assumed to be normal or Gaussian. In some instances, however, the distribution is lognormal, that is, the logarithm of the variable is normally distributed. This report presents a technique for determining the mean and standard deviation of these distributions from the cumulative distribution function. The actual distribution is compared against a standardized cumulative distribution function of mean, 5, and standard deviation, 1, (probit transformation). The relationship between the random variable and the probit is found by linear regression and the corresponding mean and standard deviation determined. Two programs are presented for solving this problem, one written for a Hewlett-Packard 9820A programmable calculator with plotter, and the other written for a digital computer in Fortran IV. As an example of the use of these programs, the platelet size distribution in a fresh blood sample, obtained from rats subjected to hyperbaric exposures and subsequently decompressed, is solved. (Author)

AD-A049 493/0CP PC **A02**/MF **A01**
Wisconsin Univ Madison Mathematics Research Center
Efficient Computer Manipulation of Tensor Products
Technical summary rept.
Carl de Boor. Nov 77, 21p Rept no. MRC-TSR-1810
Contract DAAG29-75-C-0024

Descriptors: *Computer programs, *Tensor analysis, *Interpolation, Splines(Geometry), Polynomials, Multivariate analysis, Linear systems, Approximation(Mathematics), Subroutines, Fortran.
Identifiers: Spline interpolation.

It is shown how to construct a modified version sub i of a (presumably efficient) subroutine sub i for solving the linear system A sub i x = b , i=1,...,k, so that the linear system can be solved by just one call to each of the subroutines SUB sub i . i=1,...,k. Polynomial interpolation and spline interpolation in several variables are given as examples. (Author)

AD-A049 656/2CP PC **A02**/MF **A01**
Letterman Army Inst of Research San Francisco Calif
POSTHOC: A FORTRAN IV Program for Computing One-Way Analysis of Variance and Post Hoc Dunnett, Newman-Keuls, or Scheffe Mean Comparisons
Final rept.
Ray T. Sterner, James T. Wheeler, and Lavern F. Krabill. 1974, 2p Rept no. LAIR-75-032
Availability: Pub. in Behavior Research Methods and Instrumentation, v6 n6 p569 1974.

Descriptors: *Analysis of variance, Fortran, Computer applications, Input output processing, Cell structure, Reprints.
Identifiers: Fortran 4 programming language, *POSTHOC computer program.

A computer program for post-hoc analysis of variance, applicable to either balance (equal-cell) one-way independent-groups or repeated-measures design, is briefly described. The program contains user options for Newman-Keuls, Scheffe and Dunnett evaluation of differences between cell means. (Author)

AD-A049 707/3CP PC **A08**/MF **A01**
Georgia Univ Athens Dept of Statistics and Computer Science
Interactive Statistical Software
Final rept.
Rolf E. Bargmann, and Hubert Bouver. Jan 78, 168p Rept no. THEMIS-UGA-33

Contract N00014-69-A-0423
See also AD-783 893 thru AD-793 895, AD-786 475 and AD-786 476 and AD-786 493.

Descriptors: *Statistical analysis, *Pattern recognition, *Computer graphics, Computer programs, Subroutines, Integrated systems, Numerical analysis, Statistical tests, Stochastic processes, Mathematical models, Estimates, Matrices(Mathematics), Fortran, Distribution functions, Tables(Data), Multivariate analysis.
Identifiers: Themis project, Fortran 4 programming language.

This narrative report consists of five chapters: Chapters 1 and 2 describe interactive graphical units and present examples of the use of these units, with photographs of the screen taken in the Fall of 1977, when the intergrated system was operational on the latest monitor. Chapter 3 consists of a short description of the graphics system, including examples and considerations of transportation and adaptation to other systems. Chapter 4 describes those tasks which supported the software development. especially numerical analysis work and the development and testing of efficient and precise modules. Other statistical tasks performed under this grant are described in Chapter 5. Technical details, instructions to users and programmers, important formulas, and tables and selected displays of program uses are contained in six appendix volumes to this Final Report, which were distributed in the Fall of 1974.

AD-A050 213/8CP PC **A11**/MF **A01**
Naval Postgraduate School Monterey Calif
CMS Histogram, Density Estimation and Probability Plotting Routines, with an Application to the Analysis of the Output of a Simulation of a Correlated Queue
Master's thesis
Georgios Ioannis Danikas. Dec 77, 231p

Descriptors: *Queueing theory, *Computer programs, Fortran, Output, Distribution functions, Exponential functions, Regression analysis, Cross correlation, Arrival, Time, Moments, Computer graphics, Histograms, Plotting, Subroutines, Theses.

The object of this thesis has been twofold. The first object was to develop FORTRAN versions of several existing APL programs which were designed to analyze univariate data. In particular the programs were designed to test for exponentiality and normality of the data and, by sectioning or jackknifing, obtain estimates of sampling variances of sample moments. The second object of the thesis was to use these programs in a simulation study of first-come first-served queues in which the service times and the inter-arrival times are exponentially distributed but dependent. The dependence is introduced by using the mixed moving average autoregressive structure (EARMA (p, q)) for exponential sequences. Four models of correlated queues are introduced, giving autocorrelated and cross-correlated service and arrival times in various degrees. The simulation study gives a quantitative idea of the effect of correlation on the mean waiting time and the distribution of the waiting time.

AD-A050 244/3CP PC **A03**/MF **A01**
Naval Postgraduate School Monterey Calif
Multicriteria Integer Zero-One Programming: A Tree-Search Type Algorithm
Master's thesis
Aggelos Konstantinou Simopoulos. Dec 77, 46p

Descriptors: *Integer programming, *Search theory, Algorithms, Optimization, Decision making, Efficiency, Networks, Computer programs, Theses.
Identifiers: Decision trees.

An algorithm for zero-one integer programming problems with more than one objective functions is developed, implemented and tested. For a multiobjective problem, the notion of optimality must be replaced with that of efficiency. A solution is said to be efficient if it satisfies the constraints, and no other solution satisfying them scores as well with respect to all objective functions, and better with respect to at least one of them. In the presented algorithm, the problem variables are partitioned into two sets - those whose coefficients in the objective functions are all of the same sign, and the remainder. A tree search implicit enumeration algorithm, based on this partition, is developed, and computational results are presented.(Author)

AD-A050 247/6CP PC **A03**/MF **A01**
Naval Postgraduate School Monterey Calif
Analysis and Modelling of Point Processes in Computer Science
Technical rept.
P. A. W. Lewis, and G. S. Shedler. Sep 77, 45p
Rept no. NPS-55-77-38

Descriptors: *Point processes, *Multivariate analysis, *Computer applications, Mathematical models, Computer programming, Time series analysis, Trends, Stochastic processes, Computer program reliability. Queueing theory, Networks, Clustering, Regression analysis, Discrete distribution, Poisson density functions, Reviews.

Models of univariate and multivariate series of events (point processes) and statistical methods for the analysis of point processes have diverse applications in the study of computer systems. These applications, which include the analysis and prediction of computer system reliability and the evaluation of computer system performance, are reviewed with emphasis on the latter. In addition recent results are described in the development of methodology for the statistical analysis of point processes. The analysis of multivariate point processes is much more difficult than that of univariate point processes, and that methodology has only recently been developed in a perforce fairly tentative manner. The applications to computer system data illustrate the need for new data analytic methods for handling large amounts of data, and the need for simple models for non-normal, positive multivariate time series. Some starts in these directions are indicated.

AD-A050 310/2CP PC **A02**/MF **A01**
Ballistic Research Labs Aberdeen Proving Ground Md
The Distance between a Point and an Ellipsoid
Final rept.
V. Kucher. Oct 77, 22p Rept no. BRL-2024

Descriptors: *Calculus of variations, Computer programs, Computations, Length, Lagrangian functions, Dynamic programming, Optimization, Kill probabilities, Mathematical models.
Identifiers: Lagrange multipliers.

The method of the calculus of variations is used to determine the distance from any point, not in a coordinate plane, to the surface of an ellipsoid. The distance from any point in the coordinate plane to the surface of an ellipsoid is formulated by the method of Lagrange multipliers. A computer program has been developed to compute this distance. (Author)

AD-A050 553/7CP PC **A02**/MF **A01**
Texas Univ At Austin Dept of Mathematics
Computation of g-Splines Via a Factorization Method (E2)
Harold D. Eidson, and Larry L. Schumaker. 19 Oct 72, 6p AFOSR-TR-75-1613
Grant AFOSR-69-1812
Availability: Pub in Communications of the Association of Computing Machinery, v17 n9 p526-530 Sep 74, Algorithm 485.

Descriptors: *Interpolation, *Splines(Geometry), Approximation(Mathematics), Data reduction, Curve fitting, Computations, Computer programs, Fortran, Reprints.
Identifiers: *Spline interpolation.

A program in Fortran is presented for the computation of interpolating g-splines; i.e., splines with rather general ties at the knots, and solving Hermite-Birkhoff interpolation problems. The program is also available on magnetic tape from the Department of Computer Science, University of Colorado. (Author)

AD-A050 879/6CP PC **A05**/MF **A01**
Texas Univ At Austin Center for Numerical Analysis
ITPACK Report: Numerical Studies of Several Adaptive Iterative Algorithms
David R. Kincaid, and Roger G. Grimes. Aug 77, 93p ITR-CNA-126, ARO-12301.4-M
Grant DAHC04-74-G-0198, NSF-MCS76-03141

Descriptors: *Partial differential equations, *Computer programming, Solutions(General), Iterations, Algorithms, Adaptive systems, Programming manuals, Subroutines, Fortran, Machine coding, Flow charting.
Identifiers: Elliptic differential equations, REGION subroutine.

Six adaptive iterative algorithms are studied for six elliptic partial differential equations on six regions compatible with subroutine REGION. An effort was made to make the resulting preliminary ITPACK code conform to the 'ELLPACK Contributor's Guide--Initial Version,' CSD TR 208, Purdue University, November 1, 1976. (Author)

AD-A051 536/1CP MF **A01**
Stanford Univ Calif Systems Optimization Lab
MINOS System Manual
Technical rept.
Michael A. Saunders. Dec 77, 140p SOL-77-31, ARO-12215.22-M
Contract N00014-75-C-0865, DAAG29-74-C-0034
Availability: Document partially illegible.

Descriptors: *Computer programs, *Linear programming, *Nonlinear programming, Simplex method, Solutions(General), Optimization, Problem solving, Sparse matrix, Fortran, Subroutines, Programming manuals, Computer program reliability.
Identifiers: MINOS computer program, Constraints.

MINOS is a Fortran system for solving large-scale linearly constrained optimization problems. The System Manual gives an overview of the system, the programming conventions used, data structures, tolerances, and error conditions. details are given of a practical implementation for maintaining a sparse LU factorization. The reduced-gradient approach for handling a nonlinear objective function has been described elsewhere; further implementation details are included here. The System Manual should facilitate interfacing of MINOS with other optimization software.

AD-A052 905/7CP PC **A02**/MF **A01**
Air Force Military Personnel Center Randolph AFB Tex
How to Speed up Your Transportation Model
Technical rept.
T. M. Beatty. Dec 77, 22p

Descriptors: *Transportation models, Optimization, Mathematical models, Algorithms, Decision theory, Indexes(Ratios), Problem solving, Iterations, Approximation(Mathematics), Computer programs, Computerized simulation, Cost effectiveness, Personnel management, Transportation, Air Force personnel.
Identifiers: BEST computer program.

This report presents a new method to compute a more nearly optimal initial basic feasible solution for the Transportation Model. The integration of two techniques: (1) The Decision Index (DI) and (2) An Admissability Index (AI), have resulted in 50 to 75 percent reductions in computer run time required to derive an optimal solution. (Author)

AD-A053 599/7CP PC **A04**/MF **A01**
Florida Univ Gainesville Dept of Industrial and Systems Engineering
Optimal Control of Multi-Shop Systems. Part I: Parallel Shops. Part II: Series Shops
Research rept.
Christopher Brooks Haas, and Thom J. Hodgson. Apr 78, 60p Rept no. RR-78-4
Contract N00014-76-C-0096

Descriptors: *Job shop scheduling, *Decision theory, Optimization, Computer applications, Control, Markov processes, Costs, Policies, Recursive

functions, Queueing theory, Efficiency, Computer programs.

This paper considers the optimal control structure for multi-shop (Part I: Parallel, Part II: Series) systems, where the input to the shop system is random and the shop output is determined by the number of workers in the shop. The number of workers available to the system is held constant, while control is exercised in discrete time by adjusting the allocation of workers to the various shops in the system. There is a cost for transferring workers. Additionally, there is a cost of holding backlog in the system. The control objective is to minimize the sum of these costs over an infinite horizon. It is shown that for some regions of the system's state space the optimal control policies are known exactly without resorting to computational methods. For other regions it is shown that the problem can be decomposed into subproblems of reduced complexity. Finally, an inertia (hysteresis) property is established which reduces the number of policy combinations which must be considered in some dases, and completely eliminates the necessity to determine policy in other cases. The net result is a substantial reduction in the computer storage and computational effort required to solve for the optimal control policy.

AD-A053 780/3CP PC **A04**/MF **A01**
Royal Aircraft Establishment Farnborough (England)
The Development of Quasi-Newton Methods for Unconstrained Minimisation
Technical rept.
A. G. Purcell. Aug 77, 70p RAE-TR-77132, DRIC-BR-60413
Includes addendum dated 23 Feb 78.

Descriptors: *Nonlinear programming, *Iterations, *Programming manuals, Finite difference theory, Computer programming, Optimization, Fortran, Matrices(Mathematics), Great Britain.
Identifiers: Newton method, *Unconstrained minimization.

Formulae for updating matrices in connexion with the quasi-Newton iteration are derived so as to emphasise the principles involved. Computational aspects are discussed and two FORTRAN programs for nonlinear minimisation subject to bounds on the variables are described and their use of finite difference derivatives, treatment of bounds, line searches and post-optimal sensitivity facilities are compared to demonstrate the manner in which the subject has progressed in recent years. Brief user guides to the two programs are contained in Appendices. (Author)

AD-A054 214/2CP PC **A02**/MF **A01**
Naval Surface Weapons Center White Oak Lab Silver Spring Md
An Inverse Regression Method for Determining an Ensemble of State Error Vectors from a Covariance Matrix
Interim rept.
Ronald S. Brunsvold. 5 Dec 77, 19p Rept no. NSWC/WOL/TR-77-183

Descriptors: *Matrices(Mathematics), *Linear regression analyses, Covariance, Monte Carlo method, Mathematical models, Errors, Machine coding, Computer programs, FORTRAN.
Identifiers: Covariance matrices.

A method is described to determine an ensemble of initial condition state vector errors for use in a Monte-Carlo type error model. The state vector errors are found from a given (N x N) error covarance matrix and are properly correlated with one another. The method used is an inverse regression scheme which randomly introduces a gaussion distribution of errors with determined variances about linear regression curves calculated from the given covariance matrix. A FORTRAN coded implementation of the method is included. (Author)

AD-A054 602/8CP PC **A03**/MF **A01**
David W Taylor Naval Ship Research and Development Center Bethesda Md
An Investigation of Three Computer Programs for the Solution of AX = B Where A is Symmetric and Sparse
Interim rept. Jun 77-Feb 78
Donald A. Gignac. Apr 78, 39p Rept no. DTNSRDC-78/033

Descriptors: *Matrices(Mathematics), *Computer programs, Sparse matrix, Subroutines, Structural analysis, Simultaneous equations, Linear algebraic equations, Algorithms.

This report documents an investigation of three recent programs for the solution of AX = B where A is symmetric and sparse: the Yale Sparse Matrix Package; the Munksgaard subroutines; and the Mesztenyi-Rheinboldt subroutines. The first two programs compute in-core solutions; the third uses random access to obtain its solution. The performance of these three programs is compared with that of a previously developed out-of-core equation solver, CSKYDG2. The two in-core equation solvers (especially the first) are faster than CSKYDG2; the third is slower. All three provide the same degree of accuracy as CSKYDG2, but they require large amounts of core storage. It would appear that the two in-core equation solvers are not suited for use on the CDC 6000 series of computers in their present form due to the limited amount of core storage available. Although the third equation solver does not require as much core storage, it does not perform as well as existing out-of-core euqation solvers which use the same or lesser amounts of core storage. (Author)

AD-A054 642/4CP PC **A03**/MF **A01**
Army Armament Research and Development Command Aberdeen Proving Ground Md Ballistics Research Lab
GENFIT - A Generalized, Interactive, Arbitrary Function-to-Data Fitting Routine
Final rept.
J. Terrence Klopcic. Apr 78, 36p ARBRL-MR-02832, AD-E430-035

Descriptors: *Computer programs, *Fitting functions(Mathematics), *Data reduction, Algorithms, Plotters, Nonlinear programming, Regression analysis, Plotting, Computer programming, Data processing, Iterations.
Identifiers: *GENFIT computer program, FNFIT computer program, Calcomp plotters.

The GENFIT code is an extremely versatile, multivariable, multi-parameter function to data fitting routine. Because of its simplified, complete interactive input, and many defaults, the program is also easy-to-use. Initial guesses are required; however, the search is sensitive to these guesses only if the data-producing experiment was ill-conditioned to the parameters being determined. The available output options include an easy-to-use plotting package which yields graphical comparisons between function and data. (Author)

AD-A054 833/9CP MF **A01**
Army Concepts Analysis Agency Bethesda Md
A Computer Program for Fitting Censored Samples to a Weibull Distribution (CENWEIB)
Documentation rept.
Jerry Thomas, and John Gallo. Apr 78, 59p Rept no. CAA-D-78-5
Availability: Document partially illegible.

Descriptors: *Fitting functions(Mathematics), *Computer programs, Data processing, Estimates, Statistical data, Mathematical programming, Input output processing.
Identifiers: UNIVAC-1108 computers, Weibull density functions, CENWEIB computer program, Maximum likelihood estimation.

The Censored Weibull Program (CENWEIB) is a UNIVAC 1108 computer program for fitting censored samples to a Weibull distribution or for generating random data from a Weibull distribution. Maximum likelihood estimating equations are used to calculate parameters for the two-parameter Weibull distribution. Moment estimating equations are used to calculate parameters for the three-parameter Weibull distribution. (Author)

AD-A055 425/3CP PC **A04**/MF **A01**
Naval Postgraduate School Monterey Calif
Smooth Surface Approximation by a Local Method of Interpolation at Scattered Points
Final rept. Jan-Mar 78
Richard Franke. Apr 78, 52p Rept no. NPS53-78-002

Descriptors: *Interpolation, *Computer programs, Data reduction, Approximation(Mathematics), Optimization, Weighting functions, Subroutines, Computer graphics.

This report describes a computer program which constructs a surface passing through a set of data points (x sub k,y sub k,f sub k), k = 1,...,n. It is based on previous work, but uses a somewhat different approach which takes advantage of the nature of the approximations used and incorporates experience gained in the ensuing period. The surfaces are defined for all (x,y) points and have continuous second partial derivatives.

AD-A056 369/2CP PC **A06**/MF **A01**
Army Armament Research and Development Command Aberdeen Proving Ground Md Ballistics Research Lab
User's Manual for the BRL Subroutine to Calculate Bessel Functions of Integral Order and Complex Argument
Final rept.
Kathleen L. Zimmerman, Alexander S. Elder, and Alene K. Depue. May 78, 117p ARBRL-TR-02068, AD-E430-057

Descriptors: *Bessel functions, *Subroutines, Computer programming, Computations, Boundary value problems, Asymptotic series, Iterations, Complex variables, Computer programs, FORTRAN, Input output processing.
Identifiers: Hankel functions, Continued fractions, Weber-Schlagli series.

The formulas used in the BRL Bessel Function subroutine are discussed in enough detail to enable the user to correctly implement the computer code. Accuracy limits for the Hankel Asymptotic Series are discussed in Appendix A. An annotated listing of the computer code and sample results are found in Appendix B and C. (Author)

AD-A057 230/5CP PC **A04**/MF **A01**
Naval Postgraduate School Monterey Calif
Generating Gamma and Cauchy Random Variables: An Extension to the Naval Postgraduate School Random Number Package
Technical rept.
David W. Robinson, and Peter A. W. Lewis. Apr 75, 56p Rept no. NPS-72RO75041

Descriptors: *Random number generators, Pseudo random systems, Cauchy problem, Algorithms, Computer programs.
Identifiers: IBM-360 computers, Gamma distributions, Gamma density functions, *Pseudorandom numbers.

Two very efficient algorithms for generating pseudorandom numbers from the gamma distribution have been developed; in the present work these are combined with a third method to produce a combination generator capable of excellent performance for any order of gamma variate. The algorithms are briefly described and an IBM 360 Assembler implementation of them is described and tested. A second computer program for the generation of pseudorandom Cauchy deviates is presented; this program uses a new algorithm which is also described.

AD-A057 755/1CP PC **A06**/MF **A01**
Institute for Defense Analyses Arlington Va Program Analysis Div
A Computer Program for Solving Separable Nonconvex Optimization Problems
Final rept.
Jeffrey H. Grotte, James E. Falk, and Paul F. McCoy. Jan 78, 104p P-1318, AD-E500-018

Descriptors: *Nonlinear programming, *Computer programs, Algorithms, Optimization, FORTRAN, Flow charting.

Identifiers: Branch and bound method, Nonconvex programming, MOGG computer program.

The global optima of nonconvex optimization problems are, in general, impossible to find. Many such problems, however, can be approximated arbitrarily closely by separable problems wherein all functions are piecewise linear. Program MOGG is a FORTRAN code which will find a global optimum to these latter problems. The code is based on a branch and bound algorithm that is guaranteed to terminate after a finite number of steps. The code incorporates a linear programming subsystem designed to be numerically stable even for ill-conditioned problems. (Author)

AD-A057 997/9CP PC **A02**/MF **A01**
California Univ Berkeley Electronics Research Lab
A New Proof of Global Convergence for the Tridiagonal QL Algorithm
Memorandum rept.
W. Hoffman, and B. N. Parlett. 7 Jul 77, 20p
Rept no. UCB/ERL-M77/48
Contract N00014-76-C-0013
Supported in part by Contract EY-76-S-03-0326.

Descriptors: *Matrices(Mathematics), *Algorithms, Eigenvalues, Convergence, Shifting, Computer programs, Asymptotic series, Iterations, Rotation, Plane geometry, Computations, Variations.
Identifiers: QL algorithm.

By exploiting the relation of the QL algorithm to inverse iteration, we obtain a proof of global convergence which is more conceptual and less computational than previous analyses. The proof uses a new, but simple, error estimate for the first step of inverse iteration. (Author)

AD-A057 998/7CP PC **A03**/MF **A01**
California Univ Berkeley Electronics Research Lab
A Program to Swap Diagonal Blocks
Memorandum rept.
B. N. Parlett. 3 Nov 77, 32p Rept no. UCB/ERL-M77/66
Contract N00014-76-C-0013

Descriptors: *Matrices(Mathematics), *Eigenvalues, Algorithms, Blocking, Orthogonality, Transformations(Mathematics), Exchange, Computer programs, Normalizing(Statistics), Gaussian noise, Problem solving.
Identifiers: Diagonalization.

A triangular matrix reveals its eigenvalues on the main diagonal. By Schur's lemma any square matrix is unitarily similar to an upper triangular matrix with the eigenvalues arranged in any desired order along the diagonal. In practice the QR algorithm in real arithmetic produces a block triangular matrix in which the eigenvalues are likely to be in monotone decreasing order by absolute value down the diagonal. However this monotonicity cannot be guaranteed and for some purposes the ordering by absolute value is not what is wanted. The problem which we address here is to find some simple orthogonal similarity transformations which have the effect of exchanging two diagonal elements (or blocks) while preserving block triangular form. Actually we will show only how to swap adjacent blocks and so the exchange of distant blocks must be accomplished by a succession of adjacent swaps.

AD-A058 109/0CP PC **A02**/MF **A01**
Texas Univ At Austin Center for Cybernetic Studies
NETGEN Revisited: A Program for Generating Large Scale (Un)Capacitated Assignment, Transportation, and Minimum Cost Flow Network Problems
Research rept.
David Karney, and Darwin Klingman. Jun 78, 17
Rept no. CCS-320
Contract N00014-78-C-0222, N00014-75-C-0616

Descriptors: *Computer programs, *Network flows, Transportation, Problem solving, Random number generators, Validation.
Identifiers: NETGEN computer program.

The purpose of this note is to describe a modified version of the computer program NETGEN, which can be used to generate network flow problems for testing and validation purposes. The paper also presents solutions for a set of 35 benchmark problems. (Author)

AD-A058 717/0CP PC **A02**/MF **A01**
David W Taylor Naval Ship Research and Development Center Bethesda Md
A Comparison of Three Computer Programs for the Solution of AX =B Where A is Symmetric and Sparse
Interim rept. Feb-Jun 78
Donald A. Gignac. Aug 78, 17p Rept no. DTNSRDC-78/075

Descriptors: *Matrix theory, *Computer programs, *Sparse matrix, Symmetry, Algorithms. Subroutines, High rate, Data storage systems, Efficiency, Linear systems.

This report documents a continuing investigation of two recent programs for the solution of AX=B where A is symmetric and sparse: the Yale Sparse Matrix Package and the Munksgaard subroutines. These two programs compute direct solutions in core using triangular decomposition and Gaussian elimination, respectively. Their performance is compared with that of an out-of-core Cholesky algorithm equation solver, CSKYDG2. As would be expected, the two in-core equation solvers are much faster than CSKYDG2. The Yale symmetric subroutines range up to six times faster than the Munksgaard subroutines. All three equation solvers provide the same degree of accuracy. However, the two in-core equation solvers require such enormous amounts of core storage that their use is not recommended on the CDC 6000 series of computers in their present form. While CSKYDG2 requires less core storage, its runs on the CDC 6400 cost more because of the repeated use of the random access storage ability. (Author)

AD-A058 886/3CP PC **A06**/MF **A01**
Utah Univ Salt Lake City Dept of Computer Science
Display of Complex Three Dimensional Finite Element Models
Final technical rept. 1 May 75-30 Sep 77
David C. Evans, Henry N. Christiansen, and Thomas W. Sederberg. Apr 78, 104p Rept no. UTEC-CSC-78-135
Contract N00014-75-C-0194

Descriptors: *Finite element analysis, *Mathematical models, *Computer graphics, Display systems, Topographic maps, Brain, Contours, Image processing, Mapping(Transformations), Computer programs.

Complex three dimensional models can be displayed after an automatic generation of a finite element (panel) mapping. Although this automatic generation algorithm fails at certain levels of model complexity, the elimination of these failures can be accomplished through user interaction. This report presents the algorithm solution to the problem of converting a contour definition of an arbitrary surface into a panel definition. The algorithm has been rigorously tested and experience with a highly complex data base lends credence to the claim of a general solution. Future work might focus on reducing the amount of user dependence in the algorithm, although most reasonable cases currently require no user interaction. (Author)

AD-A059 048/9CP PC **A05**/MF **A01**
Lockheed Missiles and Space Co inc Palo Alto Calif Palo Alto Research Lab
Sparse Symmetric Matrix Processing
Interim rept.
Paul S. Jensen, and John K. Reid. 26 May 78, 96p LMSC/D626184, AFOSR-TR-78-1149
Contract F49620-76-C-0003

Descriptors: *Sparse matrix, Computer programs, Symmetry, Finite element analysis, Computer applications, Solutions(General), Data reduction, Input output processing, FORTRAN.
Identifiers: Search trees.

This document describes a new sparse matrix processing system for very large symmetric matrices. It includes a description of a virtual memory system used in support of the system and results from comparison tests with a profile matrix processor on problems arising from finite-element analyses of structures.

AD-A059 719/5CP PC **A02**/MF **A01**
Florida Univ Gainesville Dept of Industrial and Systems Engineering
A Note on the Value of Interchange Methods in Scheduling Problems
Research rept.
Thom J. Hodgson, and C. Stafford Loveland. Sep 78, 23p Rept no. RR-78-12
Contract N00014-76-C-0096

Descriptors: *Scheduling, Problem solving, Heuristic methods, Machine coding, Computer programs, Parallel processors, Costs.

Consider a multi-machine scheduling problem in which the jobs (of unit duration) may have nonzero release times, monotonic increasing deferral costs, and general precedence relationships between them. In general, efficient optimal solution techniques do not exist for problems of this type, and, typically realistically sized problems must be solved using heuristics. An efficient mehtod for implementing job interchange techniques is presented for improving heuristically derived schedules. The method is tested on over 200 randomly generated (NP-complete) problems. 98.5% of the problems are solved optimally. Finally, it is noted that the quality of the solution technique does not appear to be limited by computation costs, but rather by the (one time) developmental cost of the interchange computer code.

AD-A060 348/0CP PC **A02**/MF **A01**
Southern Methodist Univ Dallas TX Dept of Operations Research and Engineering Management
Generation of Variates from Distribution Tails
Technical rept.
Bruce W. Schmeiser. Jul 78, 12p Rept no. OREM-78008
Contract N00014-77-C-0425

Descriptors: *Random number generators, *Statistical distributions, Algorithms, Normal distribution, Weibull density functions, Computer programs.
Identifiers: Beta density functions, Gamma density functions.

The general acceptance/rejection algorithm for generating random values on a computer is specialized for distribution tails, using an exponential majorizing function and a linear minorizing function. Specific algorithms are given for the normal, gamma, Weibull and beta distributions. While the algorithms can be used alone, it is anticipated that their major value will be to serve as components of algorithms for complete distributions. (Author)

AD-A060 388/6CP PC **A02**/MF **A01**
Southern Methodist Univ Dallas TX Dept of Operations Research and Engineering Management
Squeeze Methods for Generating Gamma Variates
Technical rept.
Bruce W. Schmeiser. Aug 78, 24p Rept no. OREM-78009
Contract N00014-77-C-0425
Revision of report dated Jul 78.

Descriptors: *Probability distribution functions, Random number generators, Algorithms, Random variables, Monte Carlo method, Computer programs.
Identifiers: Gamma density functions.

Two algorithms are given for generating gamma distributed random variables. The algorithms, which are valid when the shape parameter is greater than one, use a uniform majorizing function for the body of the distribution and exponential majorizing functions for the tails. The algorithms are self-contained, requiring only U(0,1) variates. Comparisons are made to three competitive algorithms in terms of marginal generation times, initialization time, and memory requirements. Both algorithms

are faster than existing methods, for all values of the shape parameters. (Author)

AD-A060 420/7CP PC **A04**/MF **A01**
Victoria Univ (British Columbia) Dept of Mathematics
Algorithms for Least-Squares Linear Prediction and Maximum Entropy Spectral Analysis
I. Barrodale, and R. E. Erickson. Aug 78, 53p
Rept no. DM-142-IR

Descriptors: *Spectrum analysis, *Least squares method, Mathematical prediction, Entropy, Error analysis, Truncation, Harmonic analysis, Algorithms, Computer programs, FORTRAN, Time series analysis, Regression analysis, Canada.
Identifiers: Toeplitz matrices.

Experience with the maximum entropy method of spectral analysis suggests that it can produce inaccurate frequency estimates of short sample sinusoidal data, and it sometimes produces calculated values for the filter coefficients that are unduly contaminated by rounding errors. Consequently, this report develops an algorithm for solving the underlying least-squares problem directly, without forcing a Toeplitz structure on the model. This approach leads to more accurate frequency determination for short sample harmonic processes, and our algorithm is computationally efficient and numerically stable. The algorithm can also be applied to two other versions of the linear prediction problem. A FORTRAN program is supplied.

AD-A060 568/3CP PC **A14**/MF **A01**
Texas A and M Univ College Station Inst of Statistics
A User's Guide to the Computer Implementation of the New Project Scheduling Procedure: Statistical PERT
Technical rept.
Thomas C. Baker, Jr, and Robert L. Sielken, Jr.
Aug 78, 303p Rept no. THEMIS-TR-57
Contract N00014-78-C-0426

Descriptors: *PERT, *Programming manuals, Scheduling, Networks, Statistical processes, Computer programs, Networks, Iterations, Cost analysis, Computer program documentation, Input output processing, Flow charting.
Identifiers: Themis project, Project management.

This report documents a new project scheduling algorithm which is a five step iterative procedure capable of determining a minimum cost project schedule when the activities making up the project have durations which are random variables. The cost of an activity is assumed to be a convex piecewise linear function of the activity's mean duration. The problem is to determine the activity mean durations which both minimize the total project cost and insure that the mean (or some specified percentile) of the corresponding project completion time distribution is less than or equal to a specified project deadline. Information on the trade-off between the project's minimum cost and its specified deadline is also provided. This report is intended as a user's guide to the new project scheduling procedure and its computer implementation. The report includes a description of the project scheduling problem a general overview of the scheduling procedure including references to technical reports documenting the development of the procedure, and an example of the procedure's performance. The documentation of the computer implementation includes specific input instructions; sample input and output; flowcharts; individual program descriptions; technical details concerning temporary data sets, job control language, and program interruption and restart procedures; and program listings.

AD-A061 065/9CP PC **A04**/MF **A01**
Naval Postgraduate School Monterey CA
Efficient Estimation of Negative Binomial Parameters Using Empirical La Place Transform
Master's thesis
Resai Caglayan. Sep 78, 68p

Descriptors: *Probability distribution functions, Binomials, Laplace transformation, Parameters, Estimates, Asymptotic normality, Tables(Data), Statistical tests, Computer programs, Theses.
Identifiers: Maximum likelihood estimation, *Binomial density functions.

A new method, based on empirical La Place transform, was developed to find asymptotically efficient estimates of negative binomial distribution parameters. These estimates were found fairly close to those found by the method of maximum likelihood. Efficiencies over 95 percent were obtained. The method was tested with a set of data, generated by computer, and found to be satisfactory except in a few cases. Maximum likelihood also fails to be satisfactory in these cases. (Author)

AD-A061 306/7CP Not available NTIS
Southern Methodist Univ Dallas TX Dept of Statistics
Communications in Statistics. Volume B7, Number 1. Simulation and Computation
D. B. Owen. 1978, 123
Contract N00014-75-C-0439
Availability: Marcel Dekker Journals, P. O. Box 11305, Church Street Station, New York, NY 10249. HC$9.00 (No copies furnished by DDC).

Descriptors: *Time series analysis, Forecasting, Regression analysis, Mathematical models, Computer programs, Matrices(Mathematics), Recursive filters, Statistical samples.
Identifiers: Box-Jenkins filters.

In recent years the Box-Jenkins method has become a popular technique for forecasting future behavior of a time series. Once the forecast model is known the method is very easy to employ and adequate computer packages are available for most purposes. Unfortunately the problem of determining the appropriate forecast model has, for models of any complexity, been one of the major stumbling blocks to the user of this method. In this paper a satisfactory solution to that problem is obtained and it is demonstrated by numerous examples how this greatly enlarges the class of data sets which can be adequately modeled by autoregressive-moving average models. This new approach is sufficiently unequivocal that most users will find it easy to implement. (Author)

AD-A061 416/4CP PC **A06**/MF **A01**
Naval Postgraduate School Monterey CA
A Procedure to Facilitate Testing of a Two-Sided Composite Null Hypothesis about the Mean of a Normally Distributed Random Variable
Master's thesis
Michael William Davis. Sep 78, 118p

Descriptors: *Statistical tests, *Random variables, Normal distribution, Population(Mathematics), Analysis of variance, Algorithms, Flow charting, Computer programs, Tables(Data), Theses.
Identifiers: Hypothesis testing, Null hypothesis, Mean.

A procedure was developed to aid in the testing of a two-sided composite null hypothesis about the mean of a normally distributed random variable for situations where either the population variance is known or unknown. The procedure was designed to eliminate the requirement for iterative type solution techniques normally used in determining the acceptance or rejection region of the subject hypothesis. This thesis provides guidelines, curves, and tables which will aid in testing a two-sided composite null hypothesis. Provisions were also incorporated into the procedure to permit testing of hypotheses about the relative displacement of the coefficient of variation from zero. (Author)

AD-A061 419/8CP PC **A04**/MF **A01**
Naval Postgraduate School Monterey CA
Myopic Search Plans
Master's thesis
Antonio Francisco de Paula Neto. Sep 78, 66p

Descriptors: Searching, Strategy, Computer applications, Interactions, Optimization, Bayes theorem, Computer programs, Theses.
Identifiers: *Search theory, Theses.

Different strategies can be used to search for a moving object. If the searcher's action at each time unit maximizes his chances of immediate detection, his strategy is said to be myopic. If, however, the searcher seeks to allocate search effort to maximize the probability of detecting the target within a preset amount of time, his strategy is called optimal. This thesis documents interactive computer programs that are useful for testing search strategies against the myopic strategy, and shows examples where the myopic strategy is not optimal.

AD-A061 561/7CP PC **A15**/MF **A01**
Army Research Office Research Triangle Park NC
Proceedings of the 1978 Army Numerical Analysis and Computers Conference held at U.S. Army Missile Research and Development Command, Redstone Arsenal, Alabama. 1 - 2 March 1978
Interim technical rept.
Oct 78, 329p Rept no. ARO-78-3

Descriptors: *Numerical methods and procedures, *Computer applications, Nonlinear programming, Interpolation, Error correction codes, Solutions(General), Bessel functions, Maxwells equations, Recursive filters, Digital filters, Transonic flow, Slender bodies, Computer programs, Computer graphics, Army research, Symposia.
Identifiers: NASTRAN computer program, Galerkin method, *Meetings.

Contents: On Error-Resistant Software Design; Primary Program Descriptions: Why We Need a New Approach to Correctness; The BRL Bessel Function Subroutine; A Semantic Updating System for Repairing Software; Software Restyling in Graphics and Programming Languages; Best Nodes for Polynomial Interpolation; Comparing Digital Filters Which produce Derivative Approximations; Computable Error Bounds for the Nystrom Method; Numerical Solutions to the Lateral Stability of a Missile; Computation of Transonic Flow Past Slender Bodies at Angle of Attack; Numerical Simulation of Electro-Chemical Machining; The CEMA Ryad Computer Family; Some Algorithms for the Analysis of Computer Programs; Solving Differential Equations on a Hand Held Programmable Calculator; The Mechanical Train Analog: A Proposed software Evaluation Tool; A Comparison of Nastran Code and Exact Solution to an Elastic-Plastic Deformation Problem; On Block Relaxation Techniques; and Software Structuring: Concepts and Methods.

AD-A061 729/0CP PC **A06**/MF **A01**
Academic Computer Center Utrecht (Netherlands)
Fast Iterative Methods for Large Linear Systems
Final technical rept.
Henk A. van der Vorst. Aug 78, 115p
Grant DA-ERO-75-G-0084

Descriptors: *Simultaneous equations, *Sparse matrix, Iterations, Solutions(General), Partial differential equations, Convergence, Boundary value problems, Eigenvalues, Computer programs, Netherlands.
Identifiers: Lanczos method, Matrix methods.

In reference 1 of the report, special splittings of the matrix of a sparse linear system were proposed. These splittings can be combined with the conjugate gradient method, which results in very efficient iterative solutions methods when the matrix is a symmetric M-matrix. The research reported in this Final Technical Report has been focused on three major subjects: a systematic overview of possible splittings for several types of matrices and eigenvalue information; applications to nonsymmetric linear systems; and solution of generalized eigenvalue problems for sparse linear systems.

AD-A062 012/0CP PC **A07**/MF **A01**
Naval Surface Weapons Center Dahlgren Lab VA
Solution of the Integer Concave Program Using the IC phi N Algorithm, Volume 2
Final rept.
Harlan W. Loomis. 1 Nov 78, 135p Rept no. NSWC/DL-TR-3120-VOL-2

Descriptors: *Integer programming, Computer program documentation, Nonlinear programming, Linear programming, Systems analysis, Algorithms, Optimization, Flow charting, Fortran, Subroutines.
Identifiers: Branch and bound method, *Concave programming, Constraints, Convex functions, Concave functions, CDC 6700 computers.

The branch-and-bound technique has been the basis for algorithms to solve both the mixed integer linear program (having linear objective function, linear constraints, and integrality restrictions on some variables) and the concave nonlinear program (having a separable concave objective function and linear constraints). The subprograms for each of these branch-and-bound algorithms are linear programs with simple upper bounds. In Volume 1, a new branch-and-bound algorithm is presented for the composite mixed integer, concave nonlinear program. This integer concave (ICON) algorithm has been implemented in the form of a computer program coded in Fortran. A guide to the use of the computer program together with examples of its application are included in Volume 1. Documentation of the computer program is included in Volume 2. (Author)

AD-705 498/CP HC A04 MF **A01**
Naval Postgraduate School Monterey Calif
A Traveling Salesman Algorithm.
Master's thesis
William Willerson White. Oct 69, 62p

Descriptors: *Linear programming, Algorithms, Networks, Optimization, Computer programs, Theses.
Identifiers: *Traveling salesman problem, Network flows, Optimal routing theory.

The study developed an algorithm to solve the traveling salesman problem. Although the program solves problems of forty cities or less, it has a significant limitation. Execution is terminated on a problem if a solution is not found early enough in the trial-and-error process of the algorithm. The solution procedure developed formulates the salesman's problem as an assignment problem, obtains an optimal assignment solution, and then manipulates vectors in the final simplex tableau until an assignment solution is obtained that also satisfies the additional traveling-salesman constraints. Background to the problem is given, the algorithm is developed and stated, the computer program is described and critiqued, highlights of computational expericnce with the program are presented, and, finally, some conclusions and recommendations are made. (Author)

AD-705 509/CP HC A04 MF **A01**
Stanford Univ Calif Dept of Computer Science
Algorithms for Matrix Multiplication.
Technical rept.
R. P. Brent. Mar 70, 56p Rept no. STAN-CS-70-157
Contract N00014-67-A-0112-0029, Grant NSF-GJ-798
Sponsored in part by Atomic Energy Commission.

Descriptors: *Matrix algebra, Numerical analysis, Iterative methods, Least squares method, Computer programs, Algorithms.
Identifiers: *Matrix multiplication, *Multiplication.

Strassen's and Winograd's algorithms for matrix multiplication are investigated and compared with the normal algorithm. Floating - point error bounds are obtained, and it is shown that scaling is essential for numerical accuracy using Winograd's method. In practical cases Winograd's method appears to be slightly faster than the other two methods, but the gain is, at most, about 20%. An attempt to generalize Strassen's method is described. (Author)

AD-705 591/CP HC A05 MF **A01**
Army Missile Command Redstone Arsenal Ala Future Missile Systems Div
Power Rates of Simultaneous Tests for Variances.
Technical rept.
Charles E. Colvin. 10 Feb 70, 88p* Rept no. RF-TR-70-1

Descriptors: *Statistical distributions, Sampling, *Analysis of variance, Determination, *Statistical tests, Power, Computer programs, Tables.
Identifiers: Bivariate density functions, Normal density functions, Bivariate normal density functions.

The report investigates the behavior of power rates associated with simultaneous tests for the variances of a bivariate normal distribution such that separate conclusions can be drawn about each parameter. The power rate is defined as the probability that one or both hypotheses are rejected when either one, or both, are not true. Alternate hypotheses were investigated when both hypotheses have either (i) two-sided, (ii) one-sided upper, or (iii) one-sided lower alternatives. (Author)

AD-705 763/CP HC A03 MF **A01**
Foreign Technology Div Wright-Patterson AFB Ohio
Program for Solving a System of Linear Equations on the Minsk-222.
L. V. Golovyashkina, and Yu. G. Kosarev. 19 Mar 70, 28p Rept no. FTD-MT-24-438-69
Edited machine trans. of Vychislitelnye Sistemy (USSR) n24 p55-75 1967, by W. W. Kennedy.

Descriptors: *Programming(Computers), Algebra, *Equations, Numerical analysis, Digital computers, Multiple operation, Computer programs, Iterative methods, USSR.
Identifiers: Minsk 222 computer system, *Linear algebraic equations, Translations.

The authors describe a universal program for solving a system of linear algebraic equations on a Minsk-222 computer system. The authors present the flowchart, discuss its basic features and computing time, and describe the memory configuration.

AD-706 003/CP HC A02 MF **A01**
Naval Research Lab Washington D C
Fortran Program for Fast Fourier Transform.
James R. Fisher. 16 Apr 70, 25p* Rept no. NRL-7041

Descriptors: *Integral transforms, Computer programs, Algorithms, Matrix algebra, Fourier analysis, Series.
Identifiers: *Fast Fourier transform, Fourier transformation, Fourier Series.

The recent development of algorithms for the rapid computation of Fourier transforms has reduced the computation time of this powerful analysis tool by orders of magnitude, enabling previously uneconomic procedures to become commonplace. In the report the fast Fourier transform (FFT) is derived from the basic equations and presented in matrix form as a means of illustrating the stage-by-stage reduction of the input data to Fourier coefficients by the algorithm. Based on this development a Fortran IV program is presented, including a full description of the statements, by relating it to the theoretical requirements. Thus a complete understanding of the FFT algorithm and program can be obtained, eliminating the constraints imposed by treating the FFT as a black box beyond the manipulative powers of the user. (Author)

AD-706 698/CP HC A03 MF **A01**
Naval Postgraduate School Monterey Calif
A Branch and Bound Algorithm for Integer and Mixed-Integer Linear Programs.
Master's thesis
Joseph Bannan Missal. Oct 69, 46p

Descriptors: *Linear programming, Algorithms, Optimization, Inequalities, Simplex method, Convergence, Computer programs, Theses.
Identifiers: *Integer programming, *Branch and bound method.

The algorithm presented is an extension of the Land and Doig branch and bound method combined with the branch selection techniques presented by Beale and Small to solve integer or mixed-integer linear programs. The algorithm obtains the solution by solving a linear program with upper and/or lower bounds on selected branch variables. By systematically changing these bounds, and maintaining only the current canonical form, the solution is assured using a minimum of excess computer storage above that required to solve the linear programming problem. Thus the problem can be solved entirely within the computer core, and the problem converges to the solution faster than most other general integer linear programming algorithms. (Author)

AD-706 710/CP HC A05 MF **A01**
Naval Postgraduate School Monterey Calif
An Examination of the Wald Stopping Bounds for the Sequential Probability Ratio Test.
Master's thesis
Michael William Gavlak. Apr 70, 96p

Descriptors: *Statistical tests, Decision theory, *Sequential analysis, Sampling, Monte Carlo method, Analysis of variance, Probability density functions, Statistical distributions, Computer programs, Simulation, Theses.
Identifiers: *Sequential probability ratio tests, Probability ratio tests, Binomial density functions, Exponential density functions, Normal density functions, Stopping rules(Mathematics), Statistical decision theory.

An examination of the Wald stopping bounds for the Sequential Probability Ratio Test (SPRT) is made by comparing results obtained from Monte Carlo simulations of sequential sampling tests with results obtained using Wald formulations. Operating Characteristic, ASN, and V(N) values are presented for test sampling from each of eight Binomial, 14 Exponential, and 24 Normal distributions. An extensive bibliography of references associated with SPRT is included. (Author)

AD-707 769/CP HC A08 MF **A01**
Wisconsin Univ Madison Mathematics Research Center
Liese II. A Program for Ordinary Differential Equations Using Lie-Series.
Technical summary rept.
H. Knapp, and G. Wanner. Aug 69, 156p Rept no. MRC-TSR-1008
Contract DA-31-124-ARO(D)-462

Descriptors: *Differential equations, Integration, *Numerical analysis, *Programming(Computers), Computer programs, Taylor's series, Integral transforms, Approximation(Mathematics).
Identifiers: *LIE series, LIESE 2 computer program, Numerical integration.

The report describes a program which computes the solutions of ordinary differential equations using Lie-series. The program accepts the system of equations in a FORTRAN-like notation and uses double precision arithmetic throughout. The various subroutines may be used for the automatic generation of Taylor-coefficients as well as for the calculation of the Jacobian of a system of functions. (Author)

AD-707 833/CP HC A05 MF **A01**
Parke Mathematical Labs Inc Carlisle Mass
Algorithms for the Evaluation of Certain Integrals Appearing in Three-Body Problems.
Final rept. Aug 67-May 70
Lorenzo Calabi. Mar 70, 76p 0061-FR, AFCRL-70-0243
Contract F19628-68-C-0061
See also AD-685 782.

Descriptors: *N-body problem, *Integration, Algorithms, ANALYTIC FUNCTIONS, Differential equations, Numerical analysis, Computer programs.
Identifiers: *Three body problem, *Volume integrals.

Algorithms are given for the evaluation of certain volume integrals needed for the bound state three-body problem. The techniques developed for the computation of residues have broad applicability. (Author)

AD-708 301/CP
California Univ Berkeley Computer Center
Handbook Series Linear Algebra. Balancing a Matrix for Calculation of Eigenvalues and Eigenvectors.
B. N. Parlett, and C. Reinsch. 1969, 12p
Contract Nonr-3656(23)
Availability: Pub. in Numer. Math., v13 p293-304 1969.

Descriptors: *Matrix algebra, Programming(Computers), Numerical analysis, Permutations, Algorithms, Computer programs.
Identifiers: Eigenvectors, Eigenvalues.

No abstract available.

AD-708 580/CP HC A02 MF **A01**
Texas A and M Univ College Station Inst of Statistics
Convex: A Computer Program for Solving Convex Programs.
Themis optimization research program
H. O. Hartley, R. R. Hocking, L. R. LaMotte, and H. H. Oxspring. Jul 70, 25p Rept no. THEMIS-TR-23
Contract N00014-68-A-0140

Descriptors: *Mathematical programming, Computer programs, Numerical analysis, Optimization, Algorithms.
Identifiers: Hartley-hocking method, Convex programming, Convex computer program, Themis project.

The report describes a computer program implementing the Hartley-Hocking convex programming algorithm. The two parts of this report are, respectively, a description of the Hartley-Hocking method as extracted from the original paper, and the documentation of the computer program. (Author)

AD-708 871/CP HC A03 MF **A01**
Watervliet Arsenal N Y
A Simple Stochastic Replacement Model.
Technical rept.
Royce W. Soanes, Jr. Jun 70, 50p Rept no. WVT-7040

Descriptors: *Replacement theory, Stochastic processes, Reliability, Statistical distributions, Life expectancy, Computer programs, Mathematical models, Optimization.
Identifiers: Weibull density functions.

The report considers the following problem: Given the failure distribution of an article, a replacement time r, the cost of replacement before failure and the (larger) cost of replacement after failure, find the expected cost per unit service time of using up n articles. An asymptotic formula for cost per unit service time is derived containing second order terms in n. The minimization of cost per unit service time with respect to r is the main objective of the analysis. (Author)

AD-709 052/CP HC A04 MF **A01**
Southern Methodist Univ Dallas Tex Dept of Statistics
Estimation and Confidence Intervals for Quantal Response or Sensitivity Data.
Guy Burton Seibert, Jr. 25 Feb 70, 69p Rept no. THEMIS-SMU-TR-66
Contract N00014-68-A-0515
Report on Themis Signal Analysis Statistics Research Program.

Descriptors: *Biological assay, Experimental data, *Statistical analysis, Decision theory, Confidence limits, Statistical distributions, Computer programs, Sensitivity, Theses.
Identifiers: Sensitivity analysis, Quantities, Statistical decision theory, Burr density functions, Maximum likelihood estimation, Themis project.

If different levels of stimuli are applied and then counts are made of the number reacting and not-reacting to the stimuli, a sensitivity analysis is usually the best analysis to be applied. Sensitivity analysis may be used to determine the probability of destroying a target with different size bombs, without the necessity of actually having data on all the different sizes. It may also be used in determining the effect of a drug on a patient or the effect of polution on a body of water. This paper is concerned with a generalized model for sensitivity analysis based on the Burr distribution. This generalization gives a model that will fit quite well data that comes from probit or logit models, but also covers many additional situations that the probit or logit models would not fit. A FORTRAN IV program is included for doing the analysis on a computer. Confidence intervals for any quantile are also given. (Author)

AD-709 062/CP HC A03 MF **A01**
Naval Postgraduate School Monterey Calif
A Comparison of Confidence Interval Procedures in Censored Life Testing Problems.
Master's thesis
William Eugene Coleman. Jun 70, 27p

Descriptors: *Reliability, *Confidence limits, Statistical distributions, Exponential functions, Life expectancy, Analysis of variance, Computer programs, Theses.
Identifiers: *Life tests, Exponential density functions.

Obtaining a confidence interval for a parameter lambda of an exponential distribution is a frequent occurrence in life testing problems. Oftentimes the test plan used is one in which all the observations are censored at the same time point. Several approximate confidence interval procedures are available in the statistical literature; however, to the knowledge of the author, the performance characteristics of the various approximations used in these procedures have not been established analytically. The purpose of this paper is to report the results of an empirical study of the performance of four of these procedures with respect to the expected length of the interval, the variance of the interval length, and the coverage probability. (Author)

AD-709 098/CP HC A03 MF **A01**
Naval Postgraduate School Monterey Calif
Investigation of the Accuracy of Using Steady-State Results to Approximate Actual System Availability.
Master's thesis
George Richard Catron. Apr 70, 41p

Descriptors: *Reliability, Systems engineering, *Replacement theory, Statistical processes, Mathematical models, Computer programs, Probability, Maintenance, Tables, Theses.
Identifiers: Erlang density functions, Exponential density functions, Laplace transformation, FORTRAN 4 programming language, FORTRAN.

Values of system availability are computed for a system whose failure density is exponential and whose repair density is special Erlang. The system is modeled as an alternating renewal process. The Laplace transform of the availability function is developed and inverted (by using a numerical procedure) to obtain the values of the system availability. Corresponding values of the long-run average system availability and the average availability over the first mission time are also computed. Comparisons are made which establish that using the long-run average value to approximate the true availability over the first mission time is a conservative practice. (Author)

AD-709 109/CP HC A03 MF **A01**
Naval Postgraduate School Monterey Calif
Methods of Estimating the Two Parameters of Life Distribution Characterized by a Linear Increasing Failure Rate, a+2BT.
Master's thesis
Gene R. Farmelo. Apr 70, 44p

Descriptors: *Reliability, Mathematical models, *Statistical distributions, Life expectancy, Exponential functions, Decision theory, Computer programs, Simulation, Theses.
Identifiers: Statistical decision theory, Parameter estimation, Maximum likelihood estimation, Moments method, Normal density functions, Exponential density functions, Wiebull density functions, Life tests.

The assumption of a linear increasing failure rate uniquely determines a life distribution which has mathematically tractable qualities. The pertinent features of this distribution are derived and listed in the paper. Three methods of estimating the two parameters of the linear increasing failure rate are derived. For each procedure a computer program is provided which performs the necessary calculations. Results using simulated failure data are listed for two of the methods of parameter estimation. (Author)

AD-709 142/CP HC A04 MF **A01**
Information Research Associates Inc Berkeley Calif
The MACYL6 Hydrodynamic Code: A Numerical Method for Calculating Incompressible Axisymmetric Time-Dependent Free-Surface Fluid Flows at High Reynolds Number.
John W. Pritchett. 15 May 70, 64p Rept no. IRA-TR-1-70
Contract N00014-70-C-0260, ARPA Order-1538

Descriptors: *Nuclear explosions, Incompressible flow, *Underwater explosions, *Numerical analysis, Hydrodynamics, Programming(Computers), Two-dimensional flow, Axially symmetric flow, Turbulence, Reynolds number.
Identifiers: MACYL6 computer program, Computer analysis.

A computer code was developed for solving incompressible two-dimensional axisymmetric time-dependent viscous fluid flow problems involving up to two free surfaces. Heuristic models for turbulence are employed to extend the method to indefinitely high Reynolds number. Scalar quantities (heat and solute concentrations) are also followed, and the fluid may be slightly nonhomogeneous in the Boussinesq approximation. The method is a second-order space, forward time explicit finite-difference scheme. Free surfaces are treated using the MAC ('Marker-and-Cell') technique. (Author)

AD-709 430/CP HC A04 MF **A01**
Naval Ammunition Depot Crane Ind Quality Evaluation Dept
Evaluating the Confidence Interval for the Reliability of General Multicomponent Systems.
Larry J. Massa. Jun 70, 75p Rept no. QETR-5

Descriptors: *Reliability(Electronics), *Confidence limits, Semiconductor devices, Electrical networks, Monte Carlo method, Statistical distributions, Exponential functions, Quality control, Computer programs, Systems engineering, Simulation.
Identifiers: Binomial density functions, Exponential density functions, FORTRAN 4 programming language, FORTRAN.

The combining of components (e.g., diodes, transistors, semiconductors, etc.) into a complex system has presented the problem of estimating the reliability of the entire system with some specified degree of confidence. Various exact and approximate methods exist for very special cases. This paper, however, reviews some of the current simulation procedures and presents a method for solving the more difficult general problem. Three forms of data input are considered. (1) Point estimates of the parameters of the assumed underlying distributions for the component failures may be made from sample data (examples are given for the binomial and exponential distributions). (2) The lower or upper reliability limit (with appropriate confidence level) may be specified for each component with no information about the sample results. (3) A subjective assessment of a prior distribution of component failure times may be given along with (1) above. A Monte Carlo simulation technique, can take any combination of these three types of data input and compute an estimate of the reliability of a simple or complex system with a relatively small error. (Author)

AD-709 877/CP HC A10 MF **A01**
Aerospace Research Labs Wright-Patterson AFB Ohio
Computing Error Bounds when the Truncation Error and Propagated Error Are of the Same Order.
Final rept.

Charles L. Keller, and Thomas E. Reeves. Apr 70, 220p Rept no. ARL-70-0069

Descriptors: *Differential equations, *Integration, *Numerical analysis, *Programming(Computers), Matrix algebra, Computer programs, Polynomials, Errors, Theorems.
Identifiers: Linear differential equations, Truncation errors.

In a previous report, a program for computing bounds for the error in a numerical solution of a system of linear differential equations is given. Experimenting with this program led to two observations: (1) In some cases a much smaller integration step size than expected would be required for several steps at the start. (2) The bound was unduly large relative to the actual error for the integration steps at the start of the program. These features, while undesirable, are not critical, in general. The reason for this behavior is discussed in this report. A program is given which can overcome these undesirable features of the program. Also given is a complete account of the equations on which this program is based. Included in this report are instructions for the use of this program and the results of a number of sample problems. These results illustrate the reasons for this program and they enable the user to check his interpretation of the instructions for the use of the program. (Author)

AD-709 926/CP HC A03 MF **A01**
Naval Postgraduate School Monterey Calif
A Goodness of Fit Test for Bivariate Normal Distributions.
Master's thesis
James Edward Miller. Apr 70, 39p

Descriptors: *Statistical distributions, Multivariate analysis, *Statistical tests, Curve fitting, Computer programs, Random variables, Sampling, Theses.
Identifiers: *Bivariate normal density functions, Normal density functions, Kolmogorov-Smirnov test, Computerized simulation.

The paper is an investigation of a goodness of fit test for bivariate normal distributions. The test procedure is based on random linear functions of bivariate normal random variables. The test makes use of the maximum Kolmogorov D(M) statistic over the linear functions which are computed. An estimate of the distribution of M is obtained by computer simulation. No attempt is made to determine the power of the test. (Author)

AD-709 927/CP HC A07 MF **A01**
Naval Postgraduate School Monterey Calif
Interactive Graph Reduction and Analysis Program.
Master's thesis
James Winton Thomas. Jun 70, 134p

Descriptors: *Graphics, Computer programs, Management planning, Flow charting, Electrical networks, Artificial intelligence, Digital computers, Theses.
Identifiers: Directed graphs, Graph theory, Interactive computer graphics, Computer graphics, PL/1 programming language, On line computers.

The paper describes the design of an interactive system to aid in the analysis of problems which involve directed graphs. The digital computing system is assumed to have a graphic display device on which directed graphs may be drawn and from which light pen, function keyboard, and alphanumeric keyboard information may be transmitted on-line to the system. Directed graphs are represented in core storage by a dynamically allocated hierarchical list structure. User-written analysis routines are linked to the system to apply it to a particular field of problems. An initial implementation of its capabilities on the IBM 360/67 with an IBM 2250 Display Unit was written in PL/I (F). Under the IBM System/360 Operating System, it executed in less than 200K bytes and provided reasonable response to on-line interaction. (Author)

AD-710 366/CP HC A05 MF **A01**
Naval Postgraduate School Monterey Calif
An Investigation of the Robustness of Student'S T Test Using beta and Erland Distributions.
Master's thesis
M. Rizwan Nomani. Sep 70, 88p

Descriptors: *Statistical tests, Power, Statistical distributions, Special functions(Mathematical), Analysis of variance, Computer programs, Sampling, Tables, Theses.
Identifiers: *T test, Robust procedures, Erlang density functions, Beta function, Gamma function.

The robustness of 'Student's' t-test with regard to the assumption of normality is investigated. This is accomplished by empirically developing the distribution of a new statistic from a large number of samples of varying sizes from the Beta and the gamma distributions using different values of the parameters. The various significance levels of this new distribution are then compared with the corresponding significance levels from 'Student's' t distribution using an IBM 360 computer. A comparison of the distribution frequencies with the standard normal distribution frequencies is also presented. (Author)

AD-710 417/CP HC A07 MF **A01**
California Univ Berkeley Operations Research Center
Enumerative Algorithms for Solving a Class of Network Synthesis Problems.
Research rept.
Robert D. Sanderson. Apr 70, 145p ORC-70-11, AROD-5307:47-M
Contract N00014-69-A-0200-1010, DA-31-124-ARO(D)-331
Sponsored in part by Grants NSF-GP-15473, NSF-GK-1684.

Descriptors: *Management planning, Flow charting, Algorithms, Cost effectiveness, Combinatorial analysis, Boundary value problems, Industrial plants, Site selection, Computer programs, Scheduling, Theses.
Identifiers: *Network flows, Branch and bound method, DISJUN computer program, Implicit enumeration, Critical path method.

A class of network flow problems having a combinatorial nature is defined. A network is synthesized by including exactly one directed arc from each of several disjoint subsets of possible arcs. All candidate arcs in a particular subset connect the same pair of nodes, and associated with each arc are five parameters: a cost of inclusion, unit cost of flow, lower and upper limits on flow, and direction of positive flow. When a network is synthesized, a least cost feasible flow is computed. The objective of the problem is to synthesize the network for which the total cost--costs of inclusion plus costs of flow--is least. In certain special cases the problem reduces to a linear minimum cost flow problem, but more frequently an enumerative technique is required. Branch-and-bound and implicit enumeration algorithms are formulated and compared. The algorithms are specialized for three applications: plant location problems, cost-time critical path scheduling with nonconvex costs, and critical path scheduling under disjunctive constraints. (Author)

AD-710 574/CP HC A02 MF **A01**
Rand Corp Santa Monica Calif
Max: A Fortran Chess Player.
James J. Gillogly. Jul 70, 9p Rept no. P-4428

Descriptors: *Game theory, Programming(Computers), Algorithms, Flow charting.
Identifiers: *Chess games, FORTRAN, FORTRAN 4 programming language, MAX computer program.

The paper describes MAX, a chess-laying program written in standard FORTRAN IV which utilizes a standard alpha-beta lookahead search of selected portions of the move tree. (Author)

AD-710 717/CP HC A03 MF **A01**
Naval Postgraduate School Monterey Calif
A Comparison of Methods for Generating Multivariate Normal Random Vectors.
Master's thesis
Norman Lee Slezak. Sep 70, 30p

Descriptors: *Statistical distributions, *Multivariate analysis, *Random variables, Sources, Probability density functions, Matrix algebra, Computer programs, Simulation, Theses.
Identifiers: Normal density functions, *Random numbers, Covariance.

Three methods for generating outcomes on multivariate normal random vectors are presented. A comparison is made to determine which method requires the least computer execution time and memory space when using the IBM 360/67. All methods use as a basis a standard Gaussian random number generator. Results of the comparison study indicate that the method based on triangular factorization of the covariance matrix generally requires less memory space and computer time than the other two methods. (Author)

AD-710 731/CP HC A07 MF **A01**
Naval Postgraduate School Monterey Calif
Evaluation of a Class of Sequential Sampling Procedures.
Master's thesis
Larry Dean Piper. Apr 70, 136p

Descriptors: *Statistical distributions, Decision theory, *Sampling, Sequential analysis, Stochastic processes, Matrix algebra, Projectile trajectories, Biological assay, Computer programs, Sensitivity, Theses.
Identifiers: Sequential estimation, Normal density functions, Random walk, Bioassay.

A class of sequential procedures for estimating the mean of a normal distribution having known variance from quantal response data is discussed. This class includes as special members the up-and-down method and other procedures commonly used in biological assay. A method of evaluating alternative procedures belonging to a given subset of the class is presented. This method is essentially an application of Wald's decision theory. A loss plus cost objective function is used and the efficiency of a particular procedure is determined by its ability to satisfy one of the four criteria considered. Criteria are discussed for use with both the expected value and variance of the total loss, which may be determined from matrix equations that are derived. Two applications are given. The first is an application to procedures commonly used in biological assay. In the second, an application to the elevation procedure of the precision registration technique used by U. S. Army and Marine Corps field artillery units, it is seen that under certain conditions, Dixon's modified up-and-down method strictly dominates the elevation procedure currently in use. (Author)

AD-710 746/CP HC A06 MF **A01**
Naval Weapons Lab Dahlgren Va
Some Applications of an Experimental Language for Symbolic Mathematics.
Technical rept.
Larry R. Diesen. Jul 70, 116p Rept no. NWL-TR-2296

Descriptors: *Programming languages, Symbols, *Differential equations, Integration, Integral transforms, Polynomials, Computer programs.
Identifiers: FLAP programming language, *Numerical integration.

The paper investigates the utility of an experimental programming language, FLAP, when applied to some typical problems of the working mathematician and engineer. The investigation is conducted by writing programs in the language to solve the following three 'typical' problems: (1) Transforming differential equations by means of a change in independent variables. (2) Obtaining Frobenius series solutions of ordinary linear, second order, differential equations with polynomial coefficients about regular and regular singular points. (3) Obtaining a prime factorization of a polynomial in one variable with integral coefficients. (Author)

AD-710 766/CP HC A04 MF **A01**
Naval Ship Engineering Center Hyattsville Md
Statistical Estimation of Demand Items for 'DDG2'.
Interim rept. no. 2
Charles J. Gaylord. Apr 70, 59p

Descriptors: *Armed Forces supplies, *Inventory control, *Destroyers, Electronic equipment, *Probability density functions, Curve fitting, Statistical distributions, Decision theory, Computer programs, Distribution functions, Sampling.
Identifiers: Poisson density functions, Binomial density functions, Statistical decision theory, DDG 2 vessel.

The paper presents the mathematical formulation of several failure distribution functions and the computation of fitting these functions to different types of sample data. It is intended that the failure distribution function be found which will best fit the DDG2 failure data. The interim report includes the fitting of Poisson and Negative Binomial Distribution to the distribution of 13 sets of sample data. (Author)

AD-711 014/CP HC A07 MF **A01**
Naval Postgraduate School Monterey Calif
A Simulation Study of Sonar (Sqs-23 Tram) Overhauls on Naval Ships.
Master's thesis
William Lawrence Fulton. Apr 70, 137p

Descriptors: *Sonar equipment, Maintenance, *Naval vessels(Combatant), Scheduling, Mathematical models, Queueing theory, Cost effectiveness, Computer programs, Theses.
Identifiers: AN/SQS-23, TRANSIM, Computerized simulation, Test reliability and maintainability, Program evaluation and review technique, Critical path method.

A demonstration is provided of using the technique of computer simulation for analyzing scheduling problems in Naval Shipyards. A model is formulated for multiple ship, concurrent, sonar (SQS-23 TRAM) overhauls at the Long Beach Naval Shipyard. This model is an extension of PERT and considers the effect of probabilistic activity times and limited personnel resources. The 'TRANSIM' simulator is utilized to assist in predicting the ship overhaul times and manpower utilization under different conditions. Two experiments are conducted which consider changes in relative overhaul commencement dates and modifications to the personnel resource levels. A complete description of the conceptual and computer models and the input coding are included in the report. (Author)

AD-711 284/CP HC A03 MF **A01**
Naval Academy Annapolis Md
Implication Algebras and Their Applications.
Research rept.
Robert J. Kimble, Jr. 15 May 70, 46p Rept no. USNA-TSPR-5
Report on A Trident Scholar Project.

Descriptors: *Mathematical logic, *Algebras, Hilbert space, Computer programs, Theorems.
Identifiers: *Implication algebras, *Lattices(Mathematics), Boolean algebra.

The study introduces a new operation, ortho-implication of orthomodular lattices that reduces to ordinary implication in the Boolean classical case. It seems that this should have definite advantages in the study of orthomodular logics, since it retains most of the properties of ordinary implication. It also makes computations somewhat easier by providing an arithmetic of its own. Finally, it generalizes the concept of orthomodular lattices to orthomodular semi-lattices. (Author)

AD-711 542/CP HC A04 MF **A01**
Auburn Univ Ala
A Fortran Program for the Solution of a Pair of Nonlinear Polynominal Ordinary Differential Equations.
Technical rept.
Leland H. Williams, Daniel C. Hoagland, and James R. Sidbury. Aug 70, 64p Rept no. THEMIS-AU-T-14
Contract DAAH01-68-C-0296
Report on Information Processing.

Descriptors: *Nonlinear differential equations, *Integration, *Numerical analysis, Computer programs, Taylor's series, Polynomials.
Identifiers: Ordinary differential equations, FORTRAN 4 programming language, FORTRAN, Themis project.

A FORTRAN 4 program which implements the solution of a pair of differential equations is presented and described. The method assumes the solution has a Taylor Series expansion and uses the Euclidean algorithm for solving a sequence of derived polynomial equations to produce the series. (Author)

AD-711 663/CP HC A08 MF **A01**
Uppsala Univ (Sweden) Seismological Inst
Regression Analysis of Statistical Data with Digital Computer Programs (Chapters 8 and 9).
Scientific rept.
Enders A. Robinson. 10 Jun 70, 172p Scientific-16, AFCRL-70-0440
Contract F61052-69-C-0037

Descriptors: *Regression analysis, Programming(Computers), Mathematical models, Analysis of variance, Mathematical prediction, correlation techniques, Distribution functions, Least squares method, Transformations(Mathematics), Sequential analysis, Matrix algebra, Sweden.
Identifiers: Orthogonality, Linear regression, Covariance, Bivariate analysis, Linear transformations.

The report consists of two chapters, whose titles are 'Linear regression model' and 'The model for multiple regression.'

AD-711 798/CP HC A03 MF **A01**
Southern Methodist Univ Dallas Tex Dept of Statistics
An Approximate Fourier Integral Transform Method for Analysis of Wave Propagation Signals.
Technical rept.
Hal Watson, Jr. Jul 70, 42p Rept no. THEMIS-SMU-TR-73
Contract N00014-68-A-0515
Report on Themis Signal Analysis Statistics Program.

Descriptors: *Signals, Propagation, *Wave transmission, *Integral transforms, Fourier analysis, Attenuation, Statistical analysis, Approximation(Mathematics), Computer programs.
Identifiers: Fourier transformation.

An analytical-numerical method of obtaining integral Fourier and inverse integral Fourier transforms is discussed. The technique was used to obtain the approximate transforms of functions, the real transforms of which are known. (Author)

AD-711 821/CP HC A04 MF **A01**
Auburn Univ Ala
An Algorithm for Fast Boolean Function Minimization Using Properties of the Cellular n-Cube.
Technical rept.
Chester C. Carroll, and William A. Hornfeck. Aug 70, 53p Rept no. THEMIS-AU-T-16
Contract DAAH01-68-C-0296
Report on Information Processing.

Descriptors: *Special functions(Mathematical), Optimization, Algorithms, Problem solving, Mathematical analysis, Mathematical logic, Design, Computer programs.
Identifiers: *Boolean functions.

Properties of the cellular n-cube representation are used to advantage in developing a fast algorithm for finding the prime implicants of a Boolean function. The algorithm is discussed and several examples are included showing computer solutions to selected Boolean function minimization problems. The complete PL/I source program listing for the automated algorithm is included. (Author)

AD-711 941/CP HC A14 MF **A01**
Oak Ridge National Lab Tenn
The Morse Code - a Multigroup Neutron and gamma-Ray Monte Carlo Transport Code.
E. A. Straker, P. N. Stevens, D. C. Irving, and V. R. Cain. Sep 70, 312p Rept no. ORNL-4585

Descriptors: *Transport properties, Monte carlo method, Gamma rays, Neutron transport theory, Numerical methods and procedures, Subroutines, Algorithms, Shielding, Mathematical models, Critical assemblies, Anisotropy, Scattering, Programming(Computers), Integral equations.
Identifiers: MORSE computer program.

The MORSE code is a multipurpose neutron and gamma-ray transport Monte Carlo code. Through the use of multigroup cross sections, the solution of neutron, gamma-ray, or coupled neutron-gamma-ray problems may be obtained in either the forward or adjoint mode. Time dependence for both shielding and criticality problems is provided. General three-dimensional geometry, as well as specialized one-dimensional geometry descriptions, may be used with an albedo option available at any material surface. A detailed discussion of the relationship between forward and adjoint flux and collision densities, as well as a detailed description of the treatment of the angle of scattering, is given in the appendices. Logical flow charts for each subroutine add to the understanding of the code. (Author)

AD-712 401/CP HC A03 MF **A01**
Iowa State Univ Ames
Parallel Tangents and Steepest Descent Optimization Algorithm-a Computer Implementation with Application to Partially Linear Models.
T. Papaioannou, and O. Kempthorne. Jul 70, 50p ARL-70-0117
Contract F33615-68-C-1343

Descriptors: *Saddle point method, Computer programs, Numerical methods and procedures, Problem solving, Iterative methods, Partial differential equations, Algorithms, Linear systems.
Identifiers: PARTAN SD computer program, Steepest descent method, Parallel tangents method.

The report presents a computer implementation of the PARTAN and steepest descent optimization algorithms. Some research on fitting partially linear models is also reported. Chapter I gives an introduction to the PARTAN and steepest descent optimization algorithms. Chapter II describes the problems solvable by the present routine. Chapter III presents an analysis of the program. Input-output considerations, data preparation and limitations of the program are given in Chapter IV. Results of test problems and a list of error messages are given in Chapters V and VI respectively. The fitting of non-linear models is discussed in Chapter VII. Finally, a listing of the computer program is given in the Appendix. (Author)

AD-712 558/CP HC A06 MF **A01**
Pennsylvania Univ Philadelphia Moore School of Electrical Engineering
Integrated Planning Systems.
Technical rept.
Robert W. Blanning. Sep 70, 123p Rept no. 71-07
Contract N00014-67-A-0216-0007

Descriptors: *Management planning, *Linear programming, Economics, Industries, Manufacturing methods, Transportation, Costs, Cost effectiveness, Iterative methods, Computer programs, Nonlinear programming, Dynamic programming.
Identifiers: Marketing, Prices, *Integrated planning systems, Investments.

The report is a discussion and evaluation of a set of preliminary experiments designed to yield insight into the development of integrated planning methods and into the design of experiments to demonstrate and test these methods. Five sets of experiments were performed consisting of: Integrating a linear programming model of a transpor-

tation network with nonlinear purchasing cost functions; Integrating two linear programming models of manufacturing facilities with a simulation of a warehouse; Integrating the pricing policies of five retail outlets; Integrating simplified purchasing, manufacturing, and marketing models; Integrating a strategic system for selecting investment projects with a simplified tactical system for yearly operations. Programs for the experiments are also presented. (Author)

AD-712 835/CP HC A03 MF **A01**
Naval Postgraduate School Monterey Calif
An Evaluation of a Modified Binary Search Procedure for Use with the Bruceton Method in Sensitivity Testing.
Master's thesis
Donald Lee Hicks. Sep 70, 43p

Descriptors: *Statistical analysis, Sensitivity, *Explosive materials, Handling, Search theory, Computer programs, Simulation, Theses.
Identifiers: Maximum likelihood estimation, Computerized simulation, Standard deviation, Statistical decision theory, Sensitivity analysis, Bruceton tests, IBM 360/67 computers, Fortran 4 programming language, Fortran.

Two methods of obtaining sensitivity data were simulated on an electronic computer for the purpose of comparing the accuracy of the estimates of the parameters of an underlying cumulative normal response function. The first method simulated the standard Bruceton procedure while the second used a modified binary search routine with a portion of the sample in order to obtain maximum likelihood estimates of the input parameters for use in a follow-on Bruceton test. The results showed both methods to be effective in estimating the mean but with slightly more variability in the estimates obtained by the second procedure. Both methods underestimated the standard deviation - again with more variability in the estimates obtained by the second procedure. When the prior parameter estimates were unknown and the applicable stimulus level bounded, the second method yielded estimates favorably comparable to those expected from the Bruceton procedure with suitable prior input estimates. (Author)

AD-712 837/CP HC A04 MF **A01**
Naval Postgraduate School Monterey Calif
An Analysis of the Sets of Rank Distribution in an Hierarchical Organization.
Master's thesis
Robert Leo Armacost. Sep 70, 54p

Descriptors: *Organizations, Supervision, *Stochastic processes, Mathematical models, Statistical distributions, Statistical tests, Numerical analysis, Set theory, Professional personnel, Matrix algebra, Computer programs, Selection, Theorems, Theses.
Identifiers: *Ranking, Markov chains.

A Markov type model for studying rank distribution in an hierarchical organization is examined. Various sets of rank distributions are defined and their properties discussed. A computer aided test is developed for testing a given rank distribution to determine if it is an element of a particular set. For a distribution not in the Steady State set, a test is developed to determine if the distribution can be returned to in m transitions or steps. (Author)

AD-712 973/CP HC A04 MF **A01**
Harry Diamond Labs Washington D C
A Fortran Program for Obtaining Approximants to Real-Valued Functions.
Nick Karayianis. Jun 70, 71p Rept no. HDL-TR-1490

Descriptors: *Functions, *Approximation(Mathematics), *Integral equations, Integration, *Numerical analysis, Computer programs, Exponential functions, Subroutines.
Identifiers: Numerical integration, FORTRAN.

A FORTRAN program is described by which systematically better approximants to a given real-valued function f(T) over 0 = or < T = or < infinity can be obtained. The program automatically generates these approximants once the user has provided the first K coefficients of the small T expansion for f(T) and the first M coefficients of the large T expansion. A punched FORTRAN deck for the desired approximant to f(T) is generated. (Author)

AD-713 049/CP HC A06 MF **A01**
Naval Postgraduate School Monterey Calif
A Computerized Algorithm for Sequential Search of the Global Maximum.
Master's thesis
Ray Lovell Springfield. Sep 70, 104p

Descriptors: *Functions, Optimization, *Search theory, Sequential analysis, Approximation(Mathematics), Numerical analysis, Computer programs, Interactions, Sampling, Algorithms, Theses.

A sequential search procedure for maximization of a single variable multimodal objective function is designed and investigated in this research. Existing sequential procedures require the function to be unimodal. Nonsequential methods, though not restricted in this sense, require a large number of samples. Results show that the proposed sequential method is in this case preferable. (Author)

AD-713 075/CP HC A04 MF **A01**
Naval Postgraduate School Monterey Calif
An AD Hoc Bayesian Method for Determining Lower Confidence Limits.
Master's thesis
John Courtney Cartland, Jr. Sep 70, 65p

Descriptors: *Confidence limits, Mathematical prediction, *Reliability, Determination, Decision theory, Computer programs, Probability, Simulation, Theses.
Identifiers: Bayesian analysis, Beta density functions, Beta function.

The thesis proposes and analyzes an ad hoc Bayesian method for determining lower confidence limits for estimates of mission reliability of single components using pass/fail test data. Several test sequences with different underlying reliabilities are simulated. After each trial the lower confidence limits are calculated using the Classical method, the Bayesian method and the proposed method. This is followed by an accuracy simulation to estimate the accuracy of the proposed method. The proposed method shows promise for future usefulness in that it is capable of demonstrating a high degree of reliability with a relatively small number of trials while maintaining some degree of protection against accepting unreliable components. (Author)

AD-713 076/CP HC A05 MF **A01**
Naval Postgraduate School Monterey Calif
A Method of Cluster Analysis.
Master's thesis
William Michael Cima. Jun 70, 76p

Descriptors: *Statistical analysis, Classification, *Pattern recognition, Mathematical prediction, Nonlinear programming, Analysis of variance, Groups(Mathematics), Curve fitting, Computer programs, Theses.
Identifiers: *Cluster analysis, Clumps, Histograms.

A method of cluster analysis is presented in which points in n-dimensional space are analyzed through a subdivisive procedure. The points are orthogonally projected onto that line which maximizes their variance and the resulting point distribution is then analyzed with the use of a histogram. Wherever possible, divisions between conglomerates of points are made and each separate clump is subsequently analyzed. Ultimately adjacent groups are combined and analyzed through an analogous technique in an effort to re-unite any points which may have inadvertently deviated from the group with which they truly associate. The method is later refined to allow the detection of groups in several point dispersions which would have appeared as a single conglomeration under the original method. An example is given to illustrate the applicability of the procedure. (Author)

AD-713 697/CP HC A07 MF **A01**
Wisconsin Univ Madison Mathematics Research Center
A Computer Program for Interactive Manipulation of Finite Group Presentations.
Technical summary rept.
F. D. Crary. Feb 70, 131p Rept no. MRC-TSR-1045
Contract DA-31-124-ARO(D)-462

Descriptors: *Groups(Mathematics), *Programming(Computers), Computer programs, Theorems.
Identifiers: Group theory, Group computer program.

An interactive computer program for manipulating finite group presentations is described. A brief mathematical background is provided along with operating instructions and notes on the programming. An illustrative example is included. (Author)

AD-713 933/CP PC **A09** MF **A01**
Naval Ammunition Depot Crane Ind Quality Evaluation Dept
Mathematical/Statistical Programs for the Wang 380 Programmable Calculator.
Herma F. Whitman, and Larry J. Massa. Sep 70, 183p Rept no. QETR-6

Descriptors: *Electronic accounting machines, Programming(Computers), *Programming(Computers), Statistical analysis, Computer programs, Simultaneous equations, Hypergeometric functions, Correlation techniques, Reliability, Interpolation, Trigonometry, Binomials, Regression analysis, Random variables, Probability.
Identifiers: WANG 380 programmable calculator.

The Wang 380 calculating system is a powerful tool in the field of applied science. The report gives many standard mathematical/statistical programs for a particular Wang system. These programs may need slight revisions for application on a different Wang system. (Author)

AD-714 073/CP PC **A08** MF **A01**
Scientific Control Systems Ltd Washington D C
The Fourth Phase of Research on Atomic Structures.
Final rept.
D. F. Mayers, and F. O'Brien. Jul 70, 175p ARL-70-0112
Contract F33615-67-C-1786
See also report dated Sep 69, AD-679 049.

Descriptors: *Atomic structure, Hartree-Fock approximation, *Hartree-Fock approximation, *Computer programs, *Atomic orbitals, Computer programs, Wave functions, Integrals.
Identifiers: *Quantum chemistry.

A program for solving the mixed relativistic and non-relativistic and non-relativistic form of the Hartree-Fock equations is discussed in detail, based on the relativistic program described under a previous contract. A program for generating continuum wave functions, in a form suitable for use with the Hartree-Fock programs previously written, is also discussed, and a complete run of the program system included. Program listings are included for the mixed relativistic and non-relativistic program. (Author)

AD-714 151/CP PC **A05** MF **A01**
Wisconsin Univ Madison Mathematics Research Center
An Interval Arithmetic Package for the UNIVAC 1108.
Technical summary rept.
Thomas D. Ladner, and J. M. Yohe. May 70, 98p Rept no. MRC-TSR-1055
Contract DA-31-124-ARO(D)-462

Descriptors: *Numerical analysis, Computer programs, Numerical methods and procedures, Real numbers, Algebra, Programming(Computers).
Identifiers: Interval arithmetic, UNIVAV 1108 computers, FORTRAN.

The report describes a program package which implements interval arithmetic for the UNIVAC 1108 computer. In addition to the basic arithmetic operations, the package provides interval versions of standard library functions, conversions to and from other data types, complete fault trapping capabilities, and other supporting functions. General guidance and references are provided to aid in the implementation of such a package for other computers. (Author)

AD-714 285/CP PC **A07** MF **A01**
Alabama Univ Huntsville Graduate School
Validating a Method of Modeling a Man-Organized System.
Master's thesis
Bob B. Lukens. 1970, 139p

Descriptors: *Management planning, Model theory, *Economics, Mathematical models, Regression analysis, Matrix algebra, Stochastic processes, Inventory control, United States Government, Costs, Computer programs, Theses.
Identifiers: Man organized systems, Control theory, Computerized simulation, SIMCO computer program, FORTRAN, FORTRAN 5 programming language, Demand(Economics), Sales, Network analysis(Management), Dynamic organizational network analysis, DONA(Dynamic Organizational Network Analysis).

The man-organized system is characterized by elements such as people, material, money, and information. The set of elements together with the relationships, define the man-organized system. The man-organized system to be considered in this thesis is a large governmental agency. In general, the method of modeling developed herein is not restricted to this type of organization. It will be seen that the method may be applicable to other organizations. In the modeling of this large governmental agency, it was required that the modeling effort be performed in a reasonably short time. The model must characterize the system through use of elemental quantities related to basic system operation. Every variable in the system need not be accounted for in the model. This results in a gross representation of the system and this was the desired approach. (Author)

AD-715 001/CP PC **A04** MF **A01**
Texas Univ Austin Center for Numerical Analysis
On the Determination of the Optimum Relaxation Factor for the Sor Method when the Eigenvalues of the Jacobi Method Are Complex.
Interim technical rept. no. 26
David M. Young, and Harold D. Eidson. Sep 70, 73p AROD-3772:61-M
Grant DA-ARO(D)-31-124-G1050, NSF-GP-8442

Descriptors: *Matrix algebra, Numerical analysis, Complex numbers, Iterations, Convergence, Partial differential equations, Algorithms, Computer programs, Theorems.
Identifiers: Eigenvalues, Relaxation method(Mathematics), OPTW computer program, Elliptic differential equations, Jacobi method, FORTRAN.

Let A be a real consistently ordered matrix with non-vanishing diagonal elements. The eigenvalues lambda of the matrix L sub omega corresponding to the successive over-relaxation method are related to the eigenvalues mu of the matrix B corresponding to the Jacobi method by Lambda + omega mu(squared root of Lambda). If the eigenvalues of B are real, then the optimum value of the relaxation factor omega in the sense of minimizing the spectral radius S(L sub omega) of omega is given by omega sub b = 2/(1+ the squared root of (1-mu bar squared)) where mu bar = S(B). The object of the present paper is to describe a method and a computer program based on this method for determining the optimum value of omega corresponding to a finite set of (complex) values of mu. (Author)

AD-715 111/CP PC **A12** MF **A01**
Houston Univ Tex Dept of Computer Science
System-State Model Theory and Implementation.
Technical rept.
John J. Lenahan. Oct 70, 251p Rept no. THEMIS-RS-2-70
Contract N00014-68-A-0151

Descriptors: *Model theory, *Programming(Computers), Mathematical models, Systems engineering, Computer programs, Simulation.
Identifiers: System state model, Directed graphs, Graph theory, FORTRAN 4 programming language, FORTRAN, Computerized simulation.

The system-state model (SSM) is both an abstract and a computational construct for representing, in the discrete time domain, at arbitrary and varying levels of specificity, the activity inherent in the processes of many classes of systems. Representable process activity may be simultaneous, asynchronous and hierarchically-related. As a formal model, the SSM represents quantitative temporal and spatial relationships among the components of the process or system being modeled. Also, as a simulation model, the SSM may accommodate representation of supplemental aspects of component activity to the extent such activity influences the formal temporal and spatial specifications. The SSM is presented first as a set-theoretic formulation involving (1) identification of the system S to be modeled, (2) transformation of S to a static representation M, (3) transformation of M to a dynamic representation M', and (4) evaluation of M'. The static representation S is described, alternatively, as a finite, directed graph involving loops and parallel lines. Secondly, the SSM is presented as a computational formulation involving (1) subsystem matrix, (2) system-state matrix, (3) transition matrix and (4) an activity procedure which operates upon the matrices. A software implementation of the computational formulation has been completed in Fortran 4 and for the IBM 360. (Author)

AD-715 297/CP PC **A03** MF **A01**
Boston Coll Chestnut Hill Mass Space Data Analysis Lab
A New Adaptive Simpson Integration Routine.
Neil Grossbard. Sep 70, 31p Scientific-1, AFCRL-70-0504
Contract F19628-70-C-0120

Descriptors: *Programming(Computers), Efficiency, *Integration, Numerical analysis, Adaptive systems, Computer programs.
Identifiers: *Numerical integration, Simpsons rule, Gaussian guadrature.

A new adaptive Simpson routine is presented and compared to other popular numerical integration methods. The relative weakness and strengths are described. An error study is included in tabular form. (Author)

AD-715 390/CP PC **A03** MF **A01**
Picatinny Arsenal Dover N J
Matric - a Program for Preparing Large Matrices Containing Blocks of Repeating Entries.
Technical memo.
Bruce D. Barnett. Aug 70, 27p Rept no. PA-TM-1961

Descriptors: *Matrix algebra, *Computer programs, Programming(Computers), Linear programming, Input-output devices.
Identifiers: MATRIC computer program, FORTRAN.

The purpose of the report is to document a computer program that facilitates the preparation of large matrices tnat contain blocks of repeating entries. (Author)

AD-715 552/CP PC **A04** MF **A01**
Naval Postgraduate School Monterey Calif
A Computer Program for Solution of Sequence Dependent Routing Problems Using a Branch-and-Bound Algorithm.
Master's thesis
Richard Alan Jackson. Sep 70, 70p

Descriptors: *Operations research, Flow charting, Scheduling, Set theory, Matrix algebra, Graphics, Computer programs, Algorithms, Theses.
Identifiers: *Branch and bound method, Traveling salesman problem, FORTRAN 4 programming language, *Network flows, Routing, FORTRAN.

An algorithm for the solution of sequence-dependent routing problems is presented and programmed in FORTRAN IV for use on digital computers. Solutions, computation times and iteration requirements are summarized and discussed for eleven test cases. With specific modification of the input data, a typical traveling salesman closed-loop problem may be solved by the same program. (Author)

AD-715 562/CP PC **A04** MF **A01**
Naval Postgraduate School Monterey Calif
Investigation of the Robustness of the Student'S T-Test under the Violation of the Assumption of Equality of Variance.
Master's thesis
Harry Alben Hadd, Jr. Dec 70, 69p

Descriptors: *Statistical tests, Power, Statistical distributions, Analysis of variance, Computer programs, Simulation, Sampling, Theses.
Identifiers: *T test, Robust procedures, Computerized simulation, Statistical inference.

The robustness of the Student's t-test is investigated under the violation of the assumption of equality of variances. With the aid of computer simulation, Type 1 and Type 2 error rates and the resulting statistical inference are studied and the effects of unequal variances on rejection rates and the power of the test are determined. Limits are determined on the degree of violation of the equality of variances that still leads to a satisfactory result when Student's distribution is used. (Author)

AD-715 634/CP PC **A03** MF **A01**
Boeing Scientific Research Labs Seattle Wash Mathematical and Information Sciences Lab
Fast Function Approximation from a Table of Data for Computer-Aided Design.
Rodney H. Allen. Oct 70, 34p Rept nos. D1-82-1007, 36

Descriptors: *Functions, *Approximation(Mathematics), *Programming(Computers), Search theory, Algorithms, Interpolation, Data processing systems, Computer programs.
Identifiers: Computer aided design, FORTRAN, Computerized simulation.

Computer-aided analysis, design, and simulation often require the approximation of several function values from tables of data many times during the execution of a computer program. Efficient table lockup and interpolation techniques may significantly reduce the required computer time. The functions f(x sub 1, ..., x sub N) to be approximated for computer-aided design programs usually have the following characteristics: Fast approximation necessary; Broad error tolerances allowed; Independent data is sequential; Independent data is often or can be equally spaced; Function is often multidimensional; Efficient program and data storage is necessary. The paper presents algorithms and computing routines for several special cases and general needs when some or all of the above characteristics are presented. (Author)

AD-715 655/CP PC **A07** MF **A01**
Cullen Coll of Engineering Houston Tex
Quasi - Solution of Multipoint Boundary Value Problems of Quasilinear Differential Equations.
Technical rept.
Bart Childs, Dennis Luckinbill, John Bryan, J. H. Boyd, Jr, and Harold Doiron. Sep 69, 128p Rept no. RE-7-69
Contract N00014-68-A-0151

Descriptors: *Boundary value problems, *Integration, *Nonlinear differential equations, Programming(Computers), Perturbation theory, Initial value problems, Numerical analysis, Iterations, Computer programs.
Identifiers: *Two point boundary value problems, *Multipoint boundary value problems, Superposition(Mathematics), *Numerical integration, Quasilinearization, QUASI computer program.

A method of solution of linear or nonlinear multipoint boundary value problems is presented with a user's manual for the computer program to implement these solutions. This is a significant generalization of two point boundary value problems. (Author)

AD-715 775/CP PC **A02** MF **A01**
Naval Research Lab Washington D C
A Fortran Computer Program for Calculating the Prolate and Oblate Angle Functions of the First Kind and Their First and Second Derivates.
B. J. King, and A. L. Van Buren. 30 Nov 70, 25p Rept no. NRL-7161

Descriptors: *Special functions(Mathematical), Numerical analysis, Differential equations, Matrix algebra, Wave functions, Series, Approximation(Mathematics), Computer programs.
Identifiers: ANGLFN computer program, FORTRAN 4 programming language, FORTRAN, *Prolate angle functions, *Oblate angle functions, Spherical harmonics, Legendre functions, Helmholtz equation, Wave equations.

The Helmholtz or scalar wave equation (deli squared + k squared) PSI = 0 is separable in both prolate and oblate spheriodal coordinates eta, xi, phi with solutions PSI = S(h, eta)R(h, eta) Phi(phi) and Psi = S(ih, eta)R(ih,--ieta)Phi(phi), respectively. Here h=kd/2, where d is the interfocal diatance. A Fortran computer program called ANGLFN has been devised to evaluate numerically the angle solutions S(h, eta and S(ih, eta. The printed output from ANFLFN consists of angle functions of the first kind, S(1)(h, eta) and S(1)(ih, eta, and their first and second derivatives with respect to eta. This report first describes the input data cards and the output format. The theory of the spheroidal wave functions is then discussed. A description of the principal internal features of ANGLFN is then given. Finally, a computer listing of ANGLFN is attached as an appendix. (Author)

AD-715 778/CP PC **A04** MF **A01**
Florida Univ Gainesville Dept of Engineering Science and Mechanics
Numerical Analysis of Plane Elastic-Plastic Boundary Value Problems: Theory and Application to Single Crystal Beam.
Technical rept.
Martin A. Eisenberg, and Byoung Sung Kim. Dec 70, 71p Rept no. TR-5
Contract N00014-68-A-0173-0002

Descriptors: *Beams(Structural), Elasticity, *Boundary value problems, Numerical analysis, Prismatic bodies, Single crystals, Plasticity, Loading(Mechanics), Bending, Computer programs, Integration, Stresses, Strain(Mechanics), Isotropism.
Identifiers: Elastoplasticity, Finite difference theory, Numerical integration.

A technique for the solution of a large class of plane elastic-plastic problems is presented and applied to the bending of a simply supported singled crystal beam. The solution of elastic-perfectly plastic problems is accomplished by means of an iterative scheme for the location of the elastic-plastic interface at given load levels. This necessitates the solution of the plane elasticity problem in domains with irregular boundaries and numerical methods are thus dictated. An appropriate finite difference method and computer code are described. This method and code can be readily extended to include effects of elastic anisotropy and non-homogeneity. (Author)

AD-716 344/CP PC **A05** MF **A01**
Picatinny Arsenal Dover N J
Table of Poisson Numbers.
Technical rept.
Donald C. Rappaport. Nov 70, 81p Rept no. PA-TR-4141

Descriptors: *Statistical distributions, Tables, *Reliability, Mathematical prediction, Approximation(Mathematics), Computer programs, Sampling, Probability, Confidence limits.
Identifiers: *Poisson density functions, Binomial density functions, FORTRAN.

The Poisson distribution is an excellent approximation of the bionomial distribution. Its formula, uses and limitations can be found in many statistics books. It is noted that the lower the defect rate, the better these numbers approximate the more exact binomial distribution. This compilation of Poisson numbers was designed to perform two functions: to estimate reliability quickly and to prepare operating characteristic curves. The FORTRAN Program used to generate these numbers was written by the author and is in Appendix A. (Author)

AD-716 347/CP PC **A03** MF **A01**
Human Engineering Labs Aberdeen Proving Ground Md
An Analysis of Variance Fortran IV Program for Small Disk-Supported Computers.
Technical memo.
Edgar M. Johnson. Dec 70, 49p Rept no. HEL-TM-31-70

Descriptors: *Computer programs, *Analysis of variance, Control sequences.
Identifiers: FORTRAN, FORTRAN 4 programming language, ANOVA computer program, IBM 1130 computers.

An analysis of variance program for small disk-supported computers was developed on an IBM 1130, 8K core and one-disk drive. This program will accept balanced analyses containing as many as eight factors in any combination of within- and between-subject effects. The number of levels of any factor is restricted only by the number of data points. On an 8K, IBM 1130, the program will accept 2050 floating-point or 4100 integer data points. Instructions for users, a FORTRAN IV listing, as well as sample problems are included. The program is easily adapted to any FORTRAN IV system with disk storage and at least 8K core. (Author)

AD-716 822/CP PC **A06** MF **A01**
Hawaii Univ Honolulu Dept of Electrical Engineering
On Direct Solutions of Linear Algebraic Systems.
Technical rept.
Nai-kuan Tsao. Dec 70, 118p THEMIS-A70-16, AFOSR-70-2932TR
Contract F44620-69-C-0030
Report on the Aloha System.

Descriptors: *Matrix algebra, Numerical analysis, Algorithms, Computer programs, Approximation(Mathematics), Iterative methods, Regression analysis, Hilbert space, Number theory.
Identifiers: FORTRAN, FORTRAN 4 programming language, Aloha system, Themis project.

A brief survey of the direct methods used in solving linear algebraic systems are presented in Chapter 2 together with a new algorithm in finding the solution or the inverse of the system. The relationship between the relative error of the solution and the system condition or machine precision is explored in Chapter 3. It is found that the relative error upper bound is linear proportional to 2 to the (-t) power where t is the number of bits used for the fractional part of a machine number in floating-point computations. Finally some remedies for solving ill-conditioned systems are described in Chapter 3. The related computer programs are listed in the Appendices. (Author)

AD-717 085/CP PC **A08** MF **A01**
California Univ Berkeley Operations Research Center
Optimal Strategies in Capacity Expansion.
Avadhesh K. Nigam. Jun 70, 166p Rept no. ORC-70-20
Contract N00014-69-A-0200-1010, Grant NSF-GK-1684
Sponsored in part by Grant PHS-EC-00260-05.
Errata sheet dated June 1970.

Descriptors: *Dynamic programming, Optimization, *Wastes(Sanitary engineering), Disposal, Management planning, Costs, Integrals, Differential equations, Integration, Decision theory, Convex sets, Stochastic processes, Matrix algebra, Computer programs, Theses.
Identifiers: Growth models, Demand(Economics), Expansion, Processing plants.

The report deals with a capacity expansion problem. Given a certain increasing demand function for a product or a service and the costs of operating processing plants of different sizes, the problem is to find the optimal size of the plants to be built and their optimal installation times in order that the present value of all future costs incurred is a minimum. (Author)

AD-717 333/CP PC **A10** MF **A01**
Yale Univ New Haven Conn Dept of Statistics
Cluster Analysis.
Technical rept.
R. F. Ling. Jan 71, 201p* Rept no. TR-18
Contract Nonr-609(52), N00014-67-A-0009-1104

Descriptors: *Statistical data, Correlation techniques, Psychometrics, Factor analysis, Monte Carlo method, Pattern recognition, Statistical distributions, Probability, Computer programs, Algorithms, Tables.
Identifiers: *Cluster analysis, Clumps, Binomial density functions, Computer graphics.

Current clustering techniques possess several common features which seem undesirable. For example, a 'cluster' remains an undefined concept; each clustering technique tends to work properly only under unstated, but often restrictive, implied assumptions; and the nonexistence of clustering statistics or the lack of theory about the sampling distributions of the statistics (when they do exist) makes the assessment of the statistical significance of a cluster quite impossible. In this paper after a brief review and critique of the clustering methods that are most widely used, definitions of a cluster and its related concepts are proposed. The clusters so defined and their associated statistics will remain invariant under any monotonic transformation of the elements of the data matrix on which they depend. Their sampling distributions are investigated by analytic and Monte Carlo methods. Both aritificial and real data are employed to illustrate the methodology and probability theory of the proposed clustering method. (Author)

AD-718 090/CP PC **A08** MF **A01**
Rand Corp Santa Monica Calif
Invariant Imbedding and the Solution of Fredholm Integral Equations with Displacement Kernels
J. L. Casti. Nov 70, 164p Rept no. R-639-PR
Contract F44620-67-C-0045

Descriptors: *Integral equations, Integration, *Initial value problems, Numerical analysis, Thermal radiation, Nonlinear systems, Cauchy problem, Analytic functions, Vector spaces, Computer programs, Theorems.
Identifiers: *Fredholm equations, *Invariant imbedding, Radiative transfer, Existence theorems, Uniqueness theorems.

A new theory is given for solving integral equations of a type that arises in many practical problems of radiative transfer through the atmosphere and in nuclear reactors. By regarding the interval length as a basic imbedding parameter rather than as a constant, two separate initial value problems are obtained for the unknown function. If the two Cauchy systems have a unique solution, that solution satisfies the original equation; if not, there is no unique solution to the original Fredholm equation. An appended FORTRAN program turns the solution of Fredholm integral equations with displacement kernels into a routine computing task. Compared with 3 standard methods--successive approximations, linear algebraic equations, and averaging functional corrections--the new program was much faster in almost all cases tried. Moreover, it automatically provides solutions for all intervai lengths less than the specified length. Finally, the report shows how to extend the concept to other types of integral equations in many important cases. (Author)

AD-718 354/CP PC **A02** MF **A01**
Center for Naval Analyses Arlington Va Operations Evaluation Group
A Computer Program for Unbalanced Analyses of Variance
Joseph Bram. Oct 70, 22p CNA-Research Conbrib-164
Contract N00014-68-A-0091

Descriptors: *Analysis of variance, *Programming(Computers), Regression analysis, Vector spaces, Subroutines, Sampling.
Identifiers: Variance subroutine, FORTRAN.

The report describes a computer subroutine which performs an analysis of variance on any set of x sub (ijk) with 3 indexes or less, i.e., where the measurements x sub (ijk) assumed normal may depend on up to 3 different factors. The number of samples for each (i,j,k) may vary with (i,j,k). In cases where there are more than 3 factors, the subroutine can still be useful; the user can choose 3 factors from the class of relevant factors in various ways, essentially aggregating the others. (Author)

AD-718 357/CP PC **A03** MF **A01**
National Research Council of Canada Ottawa (Ontario) Div of Mechanical Engineering
Fast Fourier Transform Programs for the EAI 640 Digital Computer
Mechanical engineering rept.
P. W. U. Graefe. May 70, 35p DME-MK-27, NRC-11747

Descriptors: *Integral transforms, *Computer programs, Series, Complex numbers, Digital computers, Errors, Fourier analysis, Algorithms, Canada.
Identifiers: *Fast Fourier transform, *Fourier transformation, EAI 640 computer.

The report presents a set of new programs for the computation of the Fast Fourier transform on an EAI 640 digital computer that were developed in the Mechanical Engineering Division of the National Research Council of Canada. In order to have a self-contained report on these Fast Fourier transform programs, a short summary of the properties of the discrete Fourier transform and the development of the Fast Fourier transform algorithm that is used in the digital computer programs for computing this transform, is also provided. (Author)

AD-718 859/CP PC **A03** MF **A01**
Naval Ammunition Depot Crane Ind Quality Evaluation Dept
Multivariate Analysis
Dan G. Brown. Dec 70, 33p* Rept no. QETR-7

Descriptors: *Multivariate analysis, Reviews, Statistical distributions, Statistical tests, Experimental design, Computer programs, Tables.
Identifiers: Hypothesis testing.

The paper introduces the experimenter to multivariate analysis in general and describes the difference between multivariate and univariate analysis. Multivariate procedures are given for simple hypothesis testing and the one-way multivariate analysis of variance. A computer program is also presented for the one-way Multivariate Analysis of Variance (MANOVA). (Author)

AD-719 271/CP PC **A06** MF **A01**
Research Analysis Corp Mclean Va
Nonconvex Quadratic Programming by a Modification of Lemke's Method
Technical paper
W. Charles Mylander. Feb 71, 121p Rept no. RAC-TP-414
Contract DAHC19-69-C-0017

Descriptors: *Quadratic programming, Algorithms, Set theory, Matrix algebra, Linear systems, Simplex method, Computer programs.
Identifiers: *Nonconvex programming, Constraints, Kuhn-Tucker theory.

The paper describes an algorithm that attempts to solve non-convx quadratic programs by efficiently enumerating all the points satisfying the Kuhn-Tucker conditions. The algorithm was obtained by modifying Lemke's Algorithm for solving the linear complementarity problem. The algorithm works on a wide but undelineated class of nonconvex quadratic programs. One type of nonconvex quadratic program the algorithm does solve is pseudo-convex quadratic programs. (Author)

AD-720 400/CP PC **A05** MF **A01**
Georgia Univ Athens Dept of Statistics
Comparison of Noncentral Beta Distribution Programs
Technical rept.
Carlton G. Thomas. Feb 71, 81p Rept nos. TR-62, THEMIS-UGA-10
Contract N00014-69-A-0423

Descriptors: *Statistical distributions, *Computer programs, Series, Analysis of variance, Correlation techniques, Algorithms, Theses.
Identifiers: *Beta density functions, Beta function, FORTRAN 4 programming language, FORTRAN.

The report is concerned with the development of computer programs for evaluating the noncentral Beta distributions. Two series solutions are derived from the well known infinite series expansions for the noncentral Beta distributions. These solutions consist of a finite series for integer values of n, the second degree of freedom and an infinite series solution for non-integer values of n. Both types of the noncentral Beta distribution are considered. These are the Type 1 for analysis of variance applications and the Type 2 for the noncentral distribution of the multiple correlation coefficient. A complete Fortran program listing and sample output are included. (Author)

AD-721 226/CP PC **A04** MF **A01**
Naval Postgraduate School Monterey Calif
A Comparison of the Exact and Approximate Power of the Chi-Square Goodness-of-Fit Test
Master's thesis
Brian Theodore Wright. Mar 71, 70p

Descriptors: *Statistical tests, Power, Statistical distributions, Numerical analysis, Computer programs, Sampling, Tables, Theses.
Identifiers: *Chi square test, *Goodness of fit tests.

The thesis presents a numerical comparison of the exact and approximate powers of the chi-square goodness-of-fit test for small numbers of classes and small sample sizes for the equiprobable null hypothesis. The comparison was performed using an IBM 360 computer and the computational details are presented within the thesis. In addition a comparison of critical points was conducted for the chi-square distribution and the associated exact, (multinomial), distribution. The results of the power comparisons show that the approximate power is surprisingly good and is recommended as an efficient method for determining type two error associated with the test. Further, use of the chi-square distribution for determining a critical point is reinforced through the numerical comparison of significance levels. (Author)

AD-721 230/CP PC **E01** MF **A01**
Naval Postgraduate School Monterey Calif
An Examination of the Effect of Attack Velocity on the Outcome of Lanchester-Type Engagements with Range Dependent Kill-Rates
Master's thesis
James Francis Lloyd, Jr. Mar 71, 44

Descriptors: *War games, Mathematical models, *Game theory, *Lanchester equations, Weapon systems, Kill probabilities, Attrition, Differential equations, Bessel functions, Taylor's series, Computer programs, Theses.

The thesis examines the effect of attack velocity on the outcome of Lanchester-type engagements between forces with range dependent kill-rates. Range dependent (linear and quadratic) kill-rates are considered, and analytic solutions to Lanchester-type equations are utilized in this study. By varying the attack velocity, the effects on terminal force strengths are investigated for the case when an attacking force has the initial fighting strength superiority, and for the case when a defending force has the initial fighting strength superiority. (Author)

AD-721 234/CP PC **A03** MF **A01**
Naval Postgraduate School Monterey Calif
A Comparison of Some Lanchester Models of the Skirmish
Master's thesis
Walter John III Breede. Mar 71, 46p

Descriptors: *Game theory, *Lanchester equations, *War games, Mathematical models, Counterinsurgency, Military tactics, Military strategy, Guerrilla warfare, Attrition, Kill probabilities, Differential equations, Computer programs, Simulation, Theses.
Identifiers: Scenarios.

Four Lanchester-type models are examined to investigate the hypothetical attrition process in skirmishes between ground forces. Analytic solutions are developed to Lanchester-type equations of warfare for combat between two homogeneous forces in the following circumstances: Linear-law attrition process; Square-law attrition process with constant attrition-rate coefficients; Square-law attrition process with linearly-describing time varying attrition rates; and, Square-law attrition process with exponentially-decreasing, time varying attrition rates. The above models are applied to specific combat scenarios typical of a counterinsurgency environment. The adequacy of such models as defense planning guides is discussed through a critical examination of the assumptions (both explicit and implicit) which lead to them. (Author)

AD-721 243/CP PC **A02** MF **A01**
Naval Postgraduate School Monterey Calif
A Simulation of a Transient Alternating Renewal Process
Master's thesis
George Marcellious Scherrer, Jr. Mar 71, 25p

Descriptors: *Replacement theory, Stochastic processes, *Reliability, Mathematical models, Approximation(Mathematics), Exponential functions, Statistical distributions, Computer programs, Simulation, Theses.
Identifiers: *Renewal processes, Computerized simulation, FORTRAN 4 programming language, FORTRAN, Renewal theory.

The report describes an alternating renewal process and a computer program that simulates a transient alternating renewal process. The purpose of the simulation is to test analytical approximations for the efficiency of a system described by such a process. (Author)

AD-721 290/CP PC **A03** MF **A01**
Picatinny Arsenal Dover N J
A Computer Program for Exact Reliability and Confidence Using the Hypergeometric Probability Distribution
Technical rept.
Donald C. Rappaport. Jan 71, 27p Rept no. PA-TR-4181

Descriptors: *Statistical distributions, Hypergeometric functions, *Computer programs, Instruction manuals, Quality control, Sampling, Reliability.
Identifiers: Probability distribution functions, *Hypergeometric probability distribution functions, Confidence levels, ANNERO computer program, FORTRAN.

The hypergeometric probability distribution can easily be utilized -- even by computers of desktop size -- if the method in this report is used. The first term of the distribution has been simplified and a recursive method is used for the other terms. At Picatinny Arsenal, the potentials of this computer program are the following: Exact reliability and confidence for lots and stockpiles of ammunition; Revision of specification and acceptance test procedures; Changes in sample sizes; A restatement of reliability levels; and, Drawing the exact operating characteristics curves by computer. Off-Arsenal potentials of this computer program include the following: Quality control work; Sampling of the population such as done by the Bureau of the Census or in private opinion polls; and, Obsoleting approximate statistical methods where minimum-capacity computers are available. (Author)

AD-721 495/CP PC **A03** MF **A01**
Ecole Nationale Superieure des Mines de Paris Fontainebleau (France) Centre D'Automatique
Notice d'Emploi des Programmes de Transformation de Fourier. (A Note on the Use of the Fourier Transform Program)
J. Mondelli. Jul 70, 34p P/15, AFOSR-TR-71-0864
Contract F61052-70-C-0023
Text in French; attached abstract in English.

Descriptors: *Integral transforms, *Programming(Computers), Fourier analysis, Computer programs, Algorithms, France.
Identifiers: *Fast Fourier transform, Fourier transformation, FORTRAN, FOUDEU computer program, DIANOD computer program, TRISUP computer program, TRITRA computer program.

Four Fast Fourier Transform Programs have been written in FORTRAN. They give the Fourier Transform y(s), s=0 to s=(N-1) of the series (x(t), t=0 to t=(N-1) when all the data can fit in the memory of the computer. When N is a power of 2 the program FOUDEU is to be used. When N is a product of relatively prime factors the specialized program is DIANOD. When N is merely a product of factors, two programs are available: - TRISUP which performs the Gentleman-Sande method - TRITRA which performs the Cooley-Tuckey method. (Author)

AD-721 544/CP PC **A03** MF **A01**
Naval Postgraduate School Monterey Calif
Approaches to the N-Job M-Machine Scheduling Problem
Master's thesis
Norman John Shackelton, Jr. Mar 71, 47p

Descriptors: *Machine shop practice, Scheduling, *Scheduling, Optimization, Algorithms, Sequences, Graphics, Set theory, Production control, Computer programs, Theses.
Identifiers: *Job shop scheduling, Branch and bound method, Shortest path method.

The thesis presents two methods of solving the n-job m-machine job shop scheduling problem. The criterion for optimality is the minimization of the total time to process all jobs on all machines. The technoiogical ordering of machines for each job is fixed, known, and nonrandom. The first method presented, a graphical method, indicates a lower bound and an upper bound on the optimal time to process all jobs on all machines. The second method is a branch and bound algorithm. In principle an optimal solution can always be determined by this method. Only limited computational experience is presented for the algorithm but some methods for efficient computation are suggested. (Author)

AD-721 558/CP PC **A02** MF **A01**
Naval Postgraduate School Monterey Calif
Investigation of Fit of Beta and Normal Distributions to a Product of Beta Distributions
Master's thesis
John Stager Foard, Jr. Mar 71, 24p

Descriptors: *Statistical distributions, Curve fitting, *Reliability, Systems engineering, Computer programs, Simulation, Life expectancy, Theses.
Identifiers: Beta density functions, Beta function, Normal density functions, Bayesian analysis, Method of moments, Computerized simulation, Statistical inference.

Assuming each component reliability to have a prior distribution which is beta distributed, Bayesian techniques result in the posterior distributions also being distributed. The system reliability for a series system would then be the product of the posterior distributions. Computer simulation techniques were used to determine the system reliability distribution for a series system of beta distributed components. Method of Moments techniques were then used to fit beta and normal distributions to the system distribution. The twentieth percentile points of the fitted and the actual distributions were then compared as a measure of accuracy of the fit. The fit of the beta distribution proved to be accurate for all parameter ranges and number of components in each system. The fit of the normal distribution was accurate only when used with limited parameter values. (Author)

AD-721 562/CP PC **A03** MF **A01**
Naval Postgraduate School Monterey Calif
A Linear Programming Method for Detecting Negtive Circuits with Special Application to the Assignment Problem
Master's thesis
Robert Vaughn Dennis. Mar 70, 37p

Descriptors: *Operations research, Graphics, Linear programming, Computer programs, Iterative methods, Optimization, Algorithms, Costs, Theorems, Theses.
Identifiers: *Network flows.

A new method for detecting negative cycles in a graph is proposed. This method is based upon the primal - dual relationships of a linear program formulated from an assignment problem type network. A computer program is developed for this new method to include the complete solution of the assignment problem. Results are given on program efficiency. (Author)

AD-721 581/CP PC **A06** MF **A01**
Naval Postgraduate School Monterey Calif
Fault Identification Matrix in Linear Networks
Master's thesis
Kwang Ho Yim. Sep 70, 104p

Descriptors: *Electrical networks, Failure(Electronics), Matrix algebra, Transfer functions, Differential equations, Computer programs, Reliability(Electronics), Theses.
Identifiers: *Network analysis theory, *Network synthesis, FORTRAN 4 programming language, FORTRAN, Electrical faults.

A method utilizing vector representation is investigated for determining a faulty element in passive and active networks by simple external measurements. A large system may be considered as an interconnection of a number of sub-networks. By utilizing the relationships between the magnitudes of a transfer function at various frequencies and the deviations of a circuit element, the fault simulation curves can be drawn. The fault identification regions are defined from the fault simulation curves. A fault identification matrix is constructed corresponding to the defined fault identification regions. The fault identification matrix, when premultiplied by a vector whose components are measured from a network, yields another vector whose components identify a network element which is faulty. A test procedure for the fault identification method is presented and verified. (Author)

AD-721 855/CP PC **A03** MF **A01**
Institute for Defense Analyses Arlington Va Program Analysis Div
A Convex Programming Model for Resource Allocation with Time-Dependent Objectives: SLBM Attack of Bomber Bases
Research paper
Jerome Bracken, and James T. McGill. Jul 70, 37p Rept no. RP-P-661

Descriptors: *Nonlinear programming, Optimization, *Military facilities, Jet bombers, *Guided missiles(Underwater-to-surface), Launching, *Jet bombers, Vulnerability, *Armed Forces(Foreign), Ballistic missile submarines, Random variables, Probability, Distribution functions, Matrix algebra, Subroutines, Mathematical models, Kill probabilities, Threat evaluation.
Identifiers: *Convex programming, *Allocation models, Resource allocation, SUMT computer program.

An allocation model involving distribution of resources to a set of feasible interim locations and then to an expanded set of final locations is formulated and shown to be convex programming problem. The objective is to maximize the expected value of a specified performance measure. The contribution of the resources to this measure may vary over time due to differing transit times between interim and final locations and to deteriorating values associated with final locations. The objective function is non-separable and concave, and the constraints are linear. An example is presented in which the expected number of bombers destroyed in an SLBM attack on bomber bases is maximized. (Author)

AD-722 010/CP PC **A03** MF **A01**
Naval Ordnance Lab White Oak Md
FNOL3, A Computer Program to Solve Ordinary Differential Equations
Ralph E. Ferguson, and Theodore A. Orlow. 1 Mar 71, 43p Rept no. NOLTR-71-2

Descriptors: *Differential equations, *Integration, *Computer programs, Differential equations, Integration, Simultaneous equations, Data processing systems.
Identifiers: FNOL3 computer program, FORTRAN 4 programming language, FORTRAN, *Numerical integration, Runge-Kutta method, Adams-Moulton method.

FNOL3 is a Fortran IV subprogram which uses fourth order Runge-Kutta and Adams-Moulton methods to solve up to 30 ordinary differential equations with initial conditions. Options allow control of error, step-size, print frequency and integration method. There is a discussion on the integration methods and their error terms. Listings of the subprogram and sample problems and their results as run on NOL's CDC 6400 are included. (Author)

AD-722 334/CP PC **A08** MF **A01**
Naval Research Lab Washington D C
A Machine Computation of the the Grunsky Coefficients of Schlicht Functions
Interim rept.
Allen R. Miller. 22 Mar 71, 166p Rept no. NRL-7225

Descriptors: *Analytic functions, Numerical analysis, *Programming(Computers), Instruction manuals, Computer programs, Inequalities, Power series, Theorems, Tables.
Identifiers: *Schlicht functions, Univalent functions, Bieberbach conjecture, Grunsky inequalities, FORTRAN, Computation.

No abstract available.

AD-722 565/CP PC **A03** MF **A01**
Naval Postgraduate School Monterey Calif
A Computer Simulation Analysis of a Suggested Approximate Confidence Interval for System Maintainability
Master's thesis
Carl Flack Logan. Mar 71, 38p

Descriptors: *Operations research, *Maintenance, *Reliability, Mathematical prediction, Confidence limits, Statistical distributions, Management planning, Systems engineering, Mathematical models, Computer programs, Theses.
Identifiers: Computerized simulation, Method of moments, Gamma function, Gamma density functions, Exponential density functions, Chi square density functions.

The paper presents an accuracy analysis of a suggested approximate confidence interval for system maintainability parameters. Technically, the simulation demonstrates feasible ranges of parameter applicability for a fit of linear combinations of generated gamma variates to the gamma distribution, using the method of moments. The simulation has application to the classical confidence interval for mean time to repair of a series system, under the assumptions of gamma distributed repair times, and method of moments estimators. (Author)

AD-722 648/CP PC **A03** MF **A01**
Naval Research Lab Washington D C
A Fortran Computer Program for Calculating the Prolate Spheroidal Radial Functions of the First and Second Kind and Their First Derivatives
Interim rept.
B. J. King, R. V. Baier, and S. Hanish. 30 Mar 70, 34p Rept no. NRL-7012

Descriptors: *Special functions(Mathematical), Wave functions, *Computer programs, Instruction manuals, Electromagnetic waves, Sound transmission, Bessel functions, Integration, Partial differential equations, Numerical analysis, Tables.
Identifiers: *Spheroidal functions, *Prolate spheroidal functions, *Helmholtz equation, PRAD computer program, Numerical integration, FORTRAN 4 programming language, FORTRAN.

The solutions of the Helmholtz wave equation in prolate spheroidal coordinates can be obtained by separation of variables. The subject of this report is a Fortran computer program called PRAD which calculates numerical values to the solutions of the resulting ordinary differential equation for the 'radial' coordinate. The printed output of PRAD consists of radial functions of the first and second types, their first derivatives, the separation constants or eigenvalues, and an accuracy check. The report describes the computer program PRAD and briefly reviews the theory of prolate spheroidal wave functions. A computer listing of PRAD along with some sample output is included in an appendix. (Author)

AD-722 649/CP PC **A03** MF **A01**
Naval Research Lab Washington D C
A Fortran Computer Program for Calculating the Oblate Spheroidal Radial Functions of the First and Second Kind and Their First Derivatives
Interim rept.
A. L. Van Buren, R. V. Baier, and S. Hanish. 20 Jan 70, 33p Rept no. NRL-6959

Descriptors: *Special functions(Mathematical), Wave functions, *Computer programs, Instruction manuals, Sonar signals, Sound transmission, Bessel functions, Partial differential equations, Numerical analysis, Integration, Tables.
Identifiers: *Spheroidal functions, *Prolate spheroidal functions, *Helmholtz equation, OBRAD computer program, Numerical integration, FORTRAN 4 programming language, FORTRAN.

The Helmholtz or scalar wave equation is separable in oblate spheroidal coordinates with solutions Psi. The subject of this report is a Fortran computer program called OBRAD which numerically evaluates the radial solutions. The printed output from OBRAD consists of radial functions of the first and second kind, their first derivatives, the separation constants or eigenvalues, and an accuracy check. This report first describes the input data cards and the output format. The theory of the oblate spheroidal wave function is then discussed. A description of the principal internal features of OBRAD is then given. Finally a computer listing of OBRAD is attached as an appendix. (Author)

AD-723 197/CP PC **A03** MF **A01**
Carnegie-Mellon Univ Pittsburgh Pa Management Sciences Research Group
Benefit-Cost Analysis of Coding Techniques for the Primal Transportation Algorithm
Research rept.
V. Srinivasan, and Gerald L. Thompson. Dec 70, 41p Rept no. RR-229
Contract N00014-67-A-0314-0007

Descriptors: *Mathematical programming, Efficiency, *Programming(Computers), Efficiency, Mathematical models, Transportation, Management planning, Cost effectiveness, Algorithms.
Identifiers: Benefit cost analysis, *Transportation models, Network flows, FORTRAN 5 programming language, FORTRAN, Pivot theory.

A computer code for the transportation problem that is even more efficient than the primal-dual method is developed in this paper. The code uses the well-known (primal) MODI method and is developed by a benefit-cost investigation the possible strategies for finding an initial solution, choosing the pivot element, finding the stepping-stone tour, etc. A modified row-minimum start rule, the row most negative rule for choice of pivot and a modified form of the predecessor index method for locating stepping-stone tours were found to perform best among the strategies examined. Efficient methods are devised for the relabeling that is involved in moving from one solution to another. Mean computation times for solving 175 x 175 transportation problems on the UNIVAC 1108 is 2-14 seconds depending on the data configuration. (Author)

AD-723 216/CP PC **A06** MF **A01**
Stanford Univ Calif Stanford Electronics Labs
A Study of Subharmonic Response in Nonlinear System Models
Technical rept.
Niles Ransom Moseley. Apr 71, 118p Rept nos. SU-SEL-71-018, TR-6657-3
Contract N00014-67-A-0112-0044

Descriptors: *Nonlinear differential equations, Integration, *Electrical networks, Fourier analysis, Approximation(Mathematics), Dynamic programming, Harmonic analysis, Periodic variations, Programming(Computers), Polynomials, Stability, Theorems.
Identifiers: *Network analysis theory, Spectrum analysis, Periodic functions, ADAPT N computer program, LOCAL STAB computer program, LOCAL MIN computer program, STABILITY computer program.

The report investigates the system model G(u, u dot, . . ., u sup n, t) = F(t), where F(t) is a periodic excitation. Using an approximate solution of the form u(t) = Summation, R=0 to UH (U sub c)(R) cos R (omega sub o) t + (U sub s) (R) sin R (omega sub o) t), analytical theorems and computer results are obtained that yield information into the nature of the existence and non-existence of subharmonic components in the response. By assuming G(u, u dot, . . . , u sup n, t) to be a polynomial, theorems are developed that determine the conditions for the possible existence and non-existence of subharmonic response. (Author)

AD-723 280/CP PC **E01** MF **A01**
Virginia Polytechnic Inst Blacksburg
Development of a Numerical Method to Solve the Three-Dimensional Compressible Laminar Boundary-Layer Equations with Application to Elliptical Cones at Angle of Attack
J. J. III McGowan, and R. T. Davis. Dec 70, 120 ARL-70-0341
Contract F33615-70-C-1015

Descriptors: *Partial differential equations, *Numerical analysis, *Compressible flow, Laminar boundary layer, *Superaerodynamics, Three-dimensional flow, Conical bodies, Angle of attack, Flat plate models, Thermal analysis, Integration, Computer programs.
Identifiers: Finite difference theory, Numerical integration.

A method for solving general compressible three-dimensional boundary-layer flows is developed. The equations are initially placed in a Crocco-type form which makes use of similarity variables. A general solution tehcnique which employs an implicit finite-difference scheme that is stable for negative transverse velocities is developed. As an application of the method, solutions for 10 degree vertical half-angle elliptical cones of varying ellipticity ratios at up to 8 degree angle of attack at a Mach number of 7.95 are presented. Skin friction and heat-transfer-rate distributions are presented for all cases. Good agreement is found with the experimental data of Tracy for heat-transfer rates on circular cones at angle of attack. (Author)

AD-724 794/CP PC **A05** MF **A01**
Cornell Univ Ithaca N Y Dept of Operations Research
Optimal Allocation of Observations When Comparing Several Treatments with a Control. III: Globally Best One-Sided Intervals for Unequal Variances
Technical rept.
Robert E. Bechhofer, and Bruce W. Turnbull. May 71, 85p Rept no. TR-129
Contract DA-31-124-ARO(D)-474, Nonr-401(53)
See also AD-706 373.

Descriptors: *Experimental design, *Statistical analysis, Analysis of variance, Confidence limits, Mathematical programming, Numerical analysis, Computer programs, Sampling, Optimization, Probability, Tables, Theorems.
Identifiers: integer programming.

In the paper the authors continue their earlier studies of optimal allocation of observations when comparing several treatments with a control. Previously, the authors considered one-sided and two-sided comparisons and described in detail a general allocation procedure which is globally optimal for the case in which the known variances of the 'test' populations are equal, but possibly unequal to the known variance of the 'Control' population; this same procedure is suboptimal for the case in which the known variances of the 'test' populations are unequal (although it is optimal for this latter case within a more restricted class of procedures). In the present paper the authors generalize the results to obtain the globally optimal procedure for one-sided comparisons for the case in which the known variances of the 'test' populations are unequal. (Author)

AD-725 021/CP PC **A04** MF **A01**
Rand Corp Santa Monica Calif
Estimation in a Model That Arises from Linearization in Nonlinear Least Squares Analysis
L. H. Wegner. Apr 71, 68p Rept no. R723-PR
Contract F44620-67-C-0045

Descriptors: *Least squares method, Mathematical prediction, Radar tracking, Iterative methods, Matrix algebra, Computer programs, Mathematical models, Theorems.
Identifiers: JOSS programming language, Linearization(Mathematics), Estimation theory, Covariance.

The report contains explicit formulas and a JOSS program for obtaining the minimum variance Gauss-Markov or best linear unbiased (BLUE) estimates when a directly observed parameter vector and another parameter vector are related by a possibly nonlinear relationship, and the least squares estimation procedures is linearized. The work was motivated by the need to locate a radar by indirect measurements--either directions or times of arrival of the radar signal--from aircraft whose locations were also indirectly observed by range, azimuth, and range-difference measurements from ground stations--all with some error. However, the results have wide applicability to estimation and error analysis in many real-world situations, such as combining measurements from several trackers. As the covariance matrix of the estimates evaluated at the true values of the estimated quantities generalizes the classical 'propagation of error variance formula,' the computerized covariance matrix is a versatile tool for error analysis of complex systems. (Author)

AD-725 054/CP PC **A05** MF **A01**
Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering
Tables for Unbiased Test of Equality of Variances when Sampling from Normal Distributions
Master's thesis
Joachim E. Scholz. Jun 71, 82p* Rept no. GSA/MA/71-2

Descriptors: *Analysis of variance, Statistical tests, *Statistical tests, Tables, Statistical distributions, Confidence limits, Computer programs, Sampling, Theses.
Identifiers: Normal density functions, FORTRAN.

A two sided test for the equality of variances of two random samples, each from a normal distribution, is given. The test is completely unbiased and is of minimum logarithmic length. Tables for the unbiased test for alpha-levels 0.1, 0.05, and 0.01 and instructions for their use are included. Unbiased confidence intervals may also be constructed from these tables. (Author)

AD-725 059/CP PC **A08** MF **A01**
Hawaii Univ Honolulu Dept of Electrical Engineering
Computer Analysis of Large-Scale Systems
Technical rept.

Chandrashekar Iyer. May 71, 151p THEMIS-A71-7, AFOSR-TR-71-1750
Contract F44620-69-C-0030
Report on the Aloha System.

Descriptors: *Matrix algebra, Numerical analysis, *Programming(Computers), Algorithms, Systems engineering, Simultaneous equations, Iterative methods, Mathematical programming, Computer programs, Electrical networks, Graphics, Theorems, Theses.
Identifiers: Aloha system, Themis project, *Systems theory, Frequency response, FORTRAN 4 programming language, FORTRAN, PL/1 programming language, Sparse matrix, Directed graphs, Network flows, Graph theory.

Solutions of large, sparse systems of equations need, as a rule, some preprocessing of the equations to minimize round-off errors, increase overall speed of computation and conserve memory space. Two existing major preprocessing methods are those of Kron (strong tearing) and Steward (weak tearing). Kron's method involves removal of matrix elements to reduce it to a block diagonal form and Steward's method reduces the matrix to a block triangular form by removal of one or more elements. In this dissertation the author presents a new algorithm for optimal weak tearing of large, sparse systems. Next, by working on the directed graph associated with the matrix A, the author develops a computer procedure which rapidly partitions the torn matrix into its constituent triangular blocks. Finally, rather than use an iterative method with its attendant poor convergence properties to obtain the solution of the original system the author derives a method of modified solutions. This enables the final solution to be obtained from the solution of the simple block triangular system by a very simple step. (Author)

AD-725 148/CP PC **A05** MF **A01**
Naval Ship Research and Development Center Washington D C
A Survey of Current Optimization Methods
Final rept.
Michael Gray. Jan 71, 98p Rept no. NSRDC-3605

Descriptors: *Optimization, Functions, *Search theory, Optimization, Probability, Transformations(Mathematics), Computer programs.
Identifiers: Pattern search method.

The report surveys a number of optimization methods which can be applied to non-differentiable functions. The methods include both deterministic and non-deterministic approaches to the solution of problems in optimization. The methods are discussed and compared, both in theory and by means of sample problems using computer programs supplied with the report, on the basis of such factors as efficiency, handling of constraints, and termination mechanisms. Some guidelines are offered for selection of techniques and programs most suitable for several types of problems. (Author)

AD-725 563/CP PC **A03** MF **A01**
Southern Methodist Univ Dallas Tex Dept of Statistics
The Density of the t-Statistic for Non-normal Distributions
Technical rept.
Raymond Clayton Sansing. 6 Apr 71, 38p Rept no. TR-99
Contract N00014-68-A-0515

Descriptors: *Statistical tests, Probability density functions, Statistical distributions, Approximation(Mathematics), Analysis of variance, Sampling, Computer programs, Tables, Theorems.
Identifiers: *T test, Normal density functions, Robust procedures.

The joint density function of the sample mean and sample variance is recursively derived for samples from a population with density function f where f(x) > 0 almost everywhere, everywhere continuous and has certain integral properties. For populations where f does not have these integral properties, this joint density is an approximation. This joint density function is used to derive the density function of the t-statistic for samples from f. The family of generalized normal density functions is used for an example. The approximation for the t-density is given for that family. For some specific members of the family, the true probabilities for the approximations are tabled. (Author)

AD-726 169/CP PC **A02** MF **A01**
Stanford Univ Calif Dept of Computer Science
Efficient Algorithms for Graph Manipulation
John Hopcroft, and Robert Tarjan. Mar 71, 23p
Rept no. STAN-CS-71-207
Contract N00014-67-A-0112-0057

Descriptors: *Graphics, Algorithms, Computer programs, Experimental data, Iterations, Efficiency.
Identifiers: Partitions(Mathematics), Graph theory, ALGOL.

Efficient algorithms are presented for partitioning a graph into connected components, biconnected components and simple paths. The algorithm for partitioning of a graph into simple paths is iterative and each iteration produces a new path between two vertices already on paths. (The start vertex can be specified dynamically.) If V is the number of vertices and E is the number of edges each algorithm requires time and space proportional to max(V,E) when executed on a random access computer. (Author)

AD-726 170/CP PC **A14** MF **A01**
Stanford Univ Calif Dept of Computer Science
Algorithms for Finding Zeros and Extrema of Functions Without Calculating Derivatives
Richard P. Brent. Feb 71, 324p Rept no. STAN-CS-71-198
Contract N00014-67-A-0112-0029

Descriptors: *Numerical analysis, Algorithms, *Programming(Computers), Functions, Interpolation, Convergence, Taylor's series, Partial differential equations, Convex sets, Matrix algebra, Approximation(Mathematics), Theorems, Computer programs, Digital computers.
Identifiers: ALGOL, Roots of equations.

Theorems are given concerning the order (i.e., rate) of convergence of a successive interpolation process for finding simple zeros of a function or its derivatives, using only function evaluations. Special cases include the successive linear interpolation process for finding zeros, and a parabolic interpolation process for finding turning points. Results on interpolation and finite differences include weakening the hypotheses of a theorem of Ralston on the derivative of the error in Lagrangian interpolation. The theoretical results are applied to given algorithms for finding zeros or local minima of functions of one variable, in the presence of rounding errors. The algorithms are guaranteed to converge nearly as fast as would bisection or Fibonacci search, and in most pratical cases convergence is superlinear, and much faster than for bisection or Fibonacci search. (Author)

AD-726 182/CP PC **A03** MF **A01**
Naval Ammunition Depot Crane Ind Quality Evaluation Dept
Two-Way General Analysis of Variance Program
Donald L. Jerger. Jun 71, 29p Rept no. QETR-10

Descriptors: *Analysis of variance, *Programming(Computers), Computer programs, Transformations(Mathematics), Statistical tests, Correlation techniques.

The analysis of experimental data requires more than just the running of an analysis of variance (ANOVA). Prior to performing an ANOVA one must examine the cell to cell variance and, in some cases, consider a transformation. Following the ANOVA it is usually desirable to separate (rank) the levels of the significant factor(s). The paper describes a program designed to perform these tasks in sequence in order to generalize the ANOVA for the two-factor application. (Author)

AD-726 403/CP PC **A04** MF **A01**
Harvard Univ Cambridge Mass Lab for Computer Graphics and Spatial Analysis
Geography and the Properties of Surfaces. The Sandwich Theorem - A Basic One for Geography
Interim rept.
William Warntz, C. Ernesto S. Lindgren, Katherine Kiernan, Luisa Bonfiglioli, and Eduardo Lozano. 30 Jun 71, 71p Paper-44, ONR-TR-44
Contract N00014-67-A-0298-0004
Report on Harvard Papers in Theoretical Geography.

Descriptors: *Geometry, Theorems, *Geography, Surfaces, Computer programs, Graphics, Theorems.
Identifiers: Sandwich theorem, Partitions(Mathematics), FORTRAN 4 programming language, FORTRAN, Computer graphics.

The Sandwich Theorem is a fundamental one for Geography. It provides the limiting conditions concerning spatial partitioning. As a theorem it provides information concerning the existence of solutions but not analytical means for finding them. This paper provides geometrical inter- pretations of the nature of the Sandwich Theorem and its relationship to Geography and provides an algorithm and a complete program to achieve 'solutions.' Also included is a translation of one work of Hugo Steinhaus. (Author)

AD-726 409/CP PC **A03** MF **A01**
Princeton Univ N J Dept of Electrical Engineering
A Program Implementing Piecewise Linear Approximation of Functions of Two Variables
Technical memo.
Theodosios Pavlidis. Mar 71, 40p TM-3, AROD-8244:6-A
Contract DAHC04-69-C-0035

Descriptors: *Computer programs, Instruction manuals, *Approximation(Mathematics), Functions, Curve fitting, Graphics.
Identifiers: FORTRAN, Data reduction.

The document describes the computer programs used to implement a method described in the Technical Report No. 89, 'Piecewise Approximation of Functions of Two Variables and Its Application in Topographical Data Reduction'. It contains also an example of the output of such a program. (Author)

AD-726 419/CP PC **A04** MF **A01**
Wisconsin Univ Madison Dept of Computer Sciences
A Proof of the Instability of Backward-Difference Multistep Methods for the Numerical Integration of Ordinary Differential Equations
Technical rept.
Colin W. Cryer. May 71, 57p Rept no. WIS-CS-71-117
Contract N00014-67-A-0128-0004, DA-31-124-ARO(D)-462

Descriptors: *Differential equations, Integration, Partial differential equations, Approximation(Mathematics), Numerical analysis, Complex variables, Computer programs, Polynomials, Interpolation, Theorems.
Identifiers: *Ordinary differential equations, *Numerical integration, Multistep methods, MITCHEL computer program.

It is shown that the backward difference multistep method summation, m = 1 to q of (1/m(del sup m)(y sup p))=h(f sub p) for the numerical integration of y'(x) = f(x,y) is stable in the sense of Dahlquist iff 1 = or < q = or < 6. (Author)

AD-726 622/CP PC **A05** MF **A01**
Case Western Reserve Univ Cleveland Ohio Systems Research Center
A Computer Program for Positional Games
Interim rept.
Paul F. King. Jul 71, 96p 1107, AFOSR-TR-71-1936
Grant AF-AFOSR-125-67

Descriptors: *Programming(Computers), Graphics, *Game theory, Artificial intelligence, Computer programs, Set theory, Matrix algebra, Topology, Algorithms, Learning machines, Numerical analysis.
Identifiers: Computer graphics, Graph theory.

A description is given of the theory of operation of a computer program constructed to play all games within a class termed 'positional'. Well known examples of games included within this class are furnished by the games of Hex, Go-Moku, Tic-Tac-Toe variations, and the Shannon Network games. The program's source of forcing state descriptions is described. A learning and a generation technique have been hybridized within the implementation. Working conjunctively these two methods provide the program with a highly relevant set of descriptions and an adaptive capability. (Author)

AD-726 649/CP PC **A06** MF **A01**
Case Western Reserve Univ Cleveland Ohio Systems Research Center
Experiments with an Interactive Prover for Logic with Equality
Interim rept.
Gerard Pierre Huet. Jul 71, 119p 1106, AFOSR-TR-71-1935
Grant AF-AFOSR-125-67

Descriptors: *Mathematical logic, *Programming(Computers), Computer programs, Matrix algebra, Number theory, Statistical analysis, Artificial intelligence.
Identifiers: Predicate calculus.

A computer program has been developed to prove theorems in first order predicate calculus with equality. This program accepts as input the axioms, definitions and lemmata necessary for the proof, and the negation of the theorem to be proven. It attempts to find a contradiction in this set of clauses, and in case of a success it gives the proof of the theorem, i.e., the chain of deducations necessary to find the inconsistency. The results obtained so far show that the methods used by the program are well suited to the treatment of the equality relation, and that the interactive facilities provide the user with an effective mean of communication with the program in order to direct the proof search. (Author)

AD-726 666/CP PC **A07** MF **A01**
Case Western Reserve Univ Cleveland Ohio Systems Research Center
A Program That Generates Good Difference Orderings for GPS
Daniel S. Eavarone. Nov 69, 133p SRC-69-6, AFOSR-TR-71-1943
Grant AF-AFOSR-125-67, NSF-GK-1386

Descriptors: *Programming(Computers), Problem solving, *Mathematical logic, Theorems, Artificial intelligence, Learning machines, Decision making.
Identifiers: GPS(General Problem Solver), General problem solver, Tower of Hanoi puzzle, GPS computer program, Heuristic methods.

The General Problem Solver (GPS) must be given differences, a difference ordering and a table-of-connections before it can attempt to solve a problem. Although this information is problem dependent, it is not part of the specification of the problem. Instead, giving GPS such information is a means of giving GPS hints about the nature of the problem. This report describes a program that generates a 'good' difference ordering and table of connections from the specification of the problem and the differences that are to be used. The table-of-connections differentiates between local and global relevance. Good difference orderings and table of connections are defined to be those that result in a triangular table of connections. This definition of good seems to correspond to one's initiative notions of good because the program produce difference ordering and tables-of-connections for Logic and the Tower of Hanoi that were very similar to those that were produced manually and given to GPS. These two problems were selected as examples because (1) they have been given to GPS and (2) out of the dozen problems that have been given to GPS differences turned out to be most useful in solving these two problems. (Author)

AD-727 063/CP PC **A06** MF **A01**
System Development Corp Santa Monica Calif
Contributions to Reliability
Final rept.
V. K. Murthy, and G. Boyd Swartz. Mar 71, 101p SDC-SP-3593, ARL-71-0060
Contract F33615-70-C-1183, F33615-67-C-1865
Prepared in cooperation with Monmouth Coll., N. J.
Grant NSF-GJ-214.

Descriptors: *Statistical distributions, Life expectancy, *Reliability, Mathematical prediction, Distribution functions, Statistical tests, Statistical data, Tables, Computer programs.
Identifiers: Weibull density functions, Order statistics, Parameter estimation, FORTRAN, Quantiles.

Chapter 1 of the report gives an estimate of the reciprocal of the Weibull shape parameter based on two order statistics. The exact properties are obtained for sample sizes up to 26. In Chapter 2 the properties of distributions with a designated quantile are studied. In Chapter 3 the interrelationships and properties of distributions which are respectively IHR (Increasing Hazard Rate), IHRA (Increasing Hazard Rate Average) and DMR (Decreasing Mean Residual Life) are discovered. A number of properties of life distributions that were restricted to the IHR family are shown to hold true for a wider class of hazard rate families. Finally, in Chapter 4, families of distributions that contain IHR, DHR (Decreasing Hazard Rate), constant rate (exponential) and combinations thereof, giving rise to the classical bath-tub shape hazard rate curves are characterized in a closed form and methods of estimating the parameters are discussed. (Author)

AD-727 112/CP PC **A03** MF **A01**
Naval Postgraduate School Monterey Calif
An Accuracy Analysis of an Ad Hoc Lower Confidence Limit Procedure for System Availability
Master's thesis
Bjoernar Johan Kibsgaard. Sep 71, 26p

Descriptors: *Confidence limits, Statistical distributions, *Reliability, Mathematical prediction, Exponential functions, Analysis of variance, Replacement theory, Computer programs, Simulation, Maintenance, Theses.
Identifiers: FORTRAN 4 programming language, FORTRAN, Computerized simulation, Renewal theory.

The accuracy of proposed lower confidence limits for system availability is analyzed. Random values of the lower 100(1-alpha)% confidence limit (A sub SL(alpha)) for system availability are computed for a system whose failure density is exponential and whose repair density is exponential. The system is modeled as an alternating renewal process. The 100(1-alpha) the percentile point of the generated distribution of (A sub SL(alpha)) is compared with system availability as a measure of accuracy for (A sub SL(alpha)).

AD-727 130/CP PC **A03** MF **A01**
Naval Postgraduate School Monterey Calif
Some Aspects of Estimators in Analysis of Variance Model II
Master's thesis
Gary Allen Green. Mar 71, 36p

Descriptors: *Analysis of variance, Mathematical prediction, Statistical tests, Decision theory, Sampling, Computer programs, Theses.

It is well known that the standard estimator for variance components in analysis of variance, Model 2, (sigma squared, sub a) can be negative with positive probability. In practice, when such an estimator is found to be negative it is taken to be zero. Very little is known about the properties of the corresponding truncated estimator. This thesis investigates the variance and bias of the positive truncated estimator. A method of selecting the number of classes is presented that produces maximum power for a test of the hypothesis that (sigma squared, sub a) = 0 while keeping the variance and bias as small as possible. (Author)

AD-727 367/CP REPRINT
California Univ Davis Dept of Human Physiology
Fitting Nonlinear Models to Biological Data by Marquardt's Algorithm
Gordon R. Conway, Norman R. Glass, and Jerome C. Wilcox. 21 Feb 70, 36p AFOSR-TR-71-2116
Grant AF-AFOSR-1659-69
Revision of report dated 6 Oct 69. Errata sheet inserted. Also includes 'User's Manual for MQUADT'.
Availability: Pub. in Ecology, v51 n2 p503-507 1970.

Descriptors: *Curve fitting, Experimental data, *Computer programs, Instruction manuals, Least squares method, Iterative methods, Taylor's series, Algorithms, Biology, Nonlinear systems, Mathematical models.
Identifiers: Marquardt algorithm, Parameter estimation, Logistic curves, MQUADT computer program, FORTRAN 4 programming language, FORTRAN.

Equations describing biological phenomena frequently have parameters entering nonlinearly. A highly efficient method for determining the values of parameters in such equations that will give the best least-squares fit to a set of data is Marquardt's algorithm. A step-by-step derivation of the algorithm is given in terms that require only a knowledge of elementary calculus and matrix algebra. As an example, the method is used to fit the logistic equation to a set of data. (Author)

AD-727 754/CP PC **A04** MF **A01**
Auburn Univ Ala
Some Problems Involved with Programming the Lehmer-Schur Method
Technical rept.
Susan Elaine Olszewski. Jun 70, 60p Rept no. THEMIS-AU-T-9
Contract DAAH01-68-C-0296
Master's thesis.

Descriptors: *Polynomials, *Programming(Computers), Numerical analysis, Computer programs, Tables, Theses.
Identifiers: Themis project, *Roots of equations, Lehmer-Schur method, POLY computer program, FORTRAN 4 programming language, FORTRAN.

The problems involved with programming the Lehmer-Schur Method, a machine-inspired method for finding the roots of polynomials, are studied and possible solutions are presented. Problems dealt with include the effects of the computer's limited range of numbers on the method--particularly in the area of machine underflow/overflow, and some of the problems encountered in selecting a second root-finding method to use as a backup method to the Lehmer-Schur Method. Included in addition to an outline and a theoretical background of the Lehmer-Schur Method is a program using the method along with some results obtained from it. (Author)

AD-727 800/CP PC **A03** MF **A01**
Polytechnic Inst of Brooklyn Farmingdale N Y
An APL/360 Package for the Solution of the Linear Regulator, Quadratic - Cost Riccati Equation
Technical rept.
D. C. Youla. Jun 71, 35p RADC-TR-71-112
Contract F30602-69-C-0053

Descriptors: *Differential equations, *Matrix algebra, *Adaptive control systems, Mathematical models, *Programming(Computers), Instruction manuals, Integration, Numerical analysis, Optimization, Feedback, Algorithms, Theorems.
Identifiers: *Riccati equation, *Control theory, Feedback control, Time invariant systems, B RICC TOL computer program, Regulators.

The report offers a complete APL/360 package for solving the infinite-time linear regulator problem with quadratic-cost Riccati equation. (Author)

AD-728 399/CP PC **A04** MF **A01**
Wisconsin Univ Madison Dept of Computer Sciences
The Numerical Solution of Boundary Value Problems for Second Order Functional Differential Equations by Finite Differences
Interim rept.
Colin W. Cryer. Jun 71, 62p Rept no. WIS-CS-71-127
Contract N00014-67-A-0128-0004, DA-31-124-ARO(D)-462

Descriptors: *Boundary value problems, Integration, Approximation(Mathematics), Difference equations, Numerical analysis, Computer programs, Perturbation theory, Theorems.
Identifiers: Finite difference theory, NEVERS computer program, Two point boundary value problems.

The boundary value problem x double prime (t) = g(t,x(t)) + (kappa x)(t), 0 < t < 1, x(0) = x(1) = 0, is considered. Here g : (R sup 2)(arrow)(R sup 1) and kappa : rho(0,1) (arrow) rho(0,1). The solution x is approximated using finite differences. For a large class of problems it is proved that the approximate solutions exist and converge to x. The method is illustrated by the numerical example. (Author)

AD-728 446/CP PC **A03** MF **A01**
Wisconsin Univ Madison Mathematics Research Center
The Prae-Euler Summation Method
Technical summary rept.
Karl Nickel. Apr 71, 46p Rept no. MRC-TSR-1072
Contract DA-31-124-ARO(D)-462

Descriptors: *Series, Convergence, Numerical analysis, Computer programs, Sequences, Theorems.
Identifiers: Alternating series, Triplex ALGOL 60 programming language, ALGOL.

The method prescribed accelerates the speed of convergence in a large class of alternating series. A priori bounds are given. A numerical algorithm is discussed. (Author)

AD-728 581/CP PC **A05** MF **A01**
Naval Postgraduate School Monterey Calif
An Implemented Transformational Scheme for Monic Polynomials with Integer Coefficients
Master's thesis
Robert Edward Lutz, Jr. Jun 71, 82p

Descriptors: *Polynomials, Transformations(Mathematics), *Computer programs, Instruction manuals, Rings(Mathematics), Algorithms, Theses.
Identifiers: XFORM computer program, TESTER computer program, TESTERA computer program, LUTZ2 computer program.

A discussion of the problem of the irreducibility of polynomials in the ring of integral polynomials establishes the framework of the research. A transformational scheme is postulated to facilitate investigation of the problem. The coherency of the scheme is detailed and the necessary computational techniques developed. To determine the efficacy of the transformational scheme, the specification and collection of appropriate sets of data are discussed. The transformational scheme is then applied to the data and the results are tabulated and discussed. The conclusion is drawn that a transformational scheme is a useful tool for the investigation of the irreducibility of this type of polynomial. Some hypotheses as to the refinement and extension of the technique are stated. (Author)

AD-728 673/CP PC **A04** MF **A01**
Naval Postgraduate School Monterey Calif
A Graph Theoretic Approach to the Class Scheduling Problem
Master's thesis
Charles Lewis Deitrick. Jun 71, 53p

Descriptors: *Graphics, Coloring, *Scheduling, Education, Algorithms, Topology, Computer programs, Set theory, Theses.
Identifiers: *Graph theory, Class scheduling.

Two algorithms for coloring large order graphs by partitioning, as related to class scheduling with a computer, are developed. Although, the two main algorithms failed to produce acceptable results for application to class scheduling, a coloring algorithm developed for use in the two main algorithms is an improvement over known existing coloring algorithms. (Author)

AD-728 697/CP PC **A04** MF **A01**
Naval Postgraduate School Monterey Calif
Time-Shared Computer Programs for Officer Structure Policy Planning
Master's thesis
Frank William Reifsynder, Jr. Jun 71, 61p

Descriptors: *Officer personnel, Manpower studies, *Manpower studies, *Computer programs, Personnel management, Naval personnel, Mathematical models, Time sharing, Theses.

The thesis develops two personnel flow models which can aid the manpower policy planner to predict future officer structures through the use of a time-shared computer system. The underlying structure is presented for both models. One model considers promotions based on length of commissioned service. The other model considers promotions based on length of time in grade. Computer programs are developed for both models and sample outputs are shown. The programs are used on a time-shared computer system so that the policy planner can interact with the computer with a minimal knowledge of computer programming. The computer output is in a concise, easy to understand form. (Author)

AD-728 828/CP PC **A03** MF **A01**
Army Materiel Systems Analysis Agency Aberdeen Proving Ground Md
NORGEB - A BRLESC II Computer Program Which Performs a X2-Goodness of Fit Test for the Normal, Gamma, Exponential, and Beta Probability Distributions
Technical memo.
Wayne S. Copes. Jun 71, 48p Rept no. AMSAA-TM-107

Descriptors: *Statistical tests, *Computer programs, *Probability density functions, Curve fitting, Statistical distributions, Exponential functions, Sampling.
Identifiers: NORGEB computer program, FORTRAN 4 programming language, FORTRAN, Chi square test, Normal density functions, Exponential density functions, Beta density functions, Beta function, Gamma density functions, Gamma function, Standard deviation, Statistical inference, Degrees of freedom, Mean.

NORGEB is a computer program which tests the hypothesis that a sample is drawn from a normal, gamma, exponential, or beta probability distribution. This is accomplished by computing a chi square-test statistic and accompanying degrees of freedom. The parameters for the theoretical distributions are estimated from the sample. For each sample tested, the mean, standard deviation, maximum and minimum data points, and a listing of the sample data are given. For each test performed, a chi square-test statistic, associated degrees of freedom, and frequency distribution in the form of a bar chart are given. The program is written in FORTRAN 4 for the Ballistic Research Laboratory Electronic Scientific Computer (BRLESC 2). (Author)

AD-728 833/CP PC **A10** MF **A01**
Texas Univ El Paso
Evaluation of Bessel Functions with Imaginary Order for Applications to Certain Boundary-Value Problems
Final technical rept. 1 Jul 69-30 Jun 70
Phillip H. Duran. Jun 70, 222p ECOM-0359-F
Contract DAAD07-69-C-0359

Descriptors: *Bessel functions, Tables, *Sound transmission, *Boundary value problems, Asymptotic series, Partial differential equations, Numerical analysis, Integration, Saddle point method, Underwater sounding, Complex variables, Power series, Computer programs, Atmosphere, Diffraction, Theses.
Identifiers: Wave equations, FORTRAN 4 programming language, FORTRAN, BESSEL J computer program.

The paper treats the mathematics of the Bessel function (J sub nu)(z) for large order and argument, resulting in the tabulation of values of the (J sub nu)(z) and (J sub n)(x) functions for pure imaginary order nu = in and complex argument z, and for real order n and real argument x, for n = 100, 1000, 10000, and 100000. Heretofore, tables of imaginary order were not available in the literature, and have now been computed in this work for the purpose of applying them to the theory of sound propagation in a medium where the conditions are such as to produce shadow zones. Of particular interest are future applications to the yet unsolved problem of computing mathematically the intensity of sound in the atmospheric shadow zone in terms of wind gradients. The Bessel function evaluations are based on Debye's asymptotic expansions. (Author)

AD-729 437/CP PC **A08** MF **A01**
Michigan Univ Ann Arbor Systems Engineering Lab
Finding Optimal Groups - A Quadratic Programming Approach in Zero/One Variables with Applications
Technical rept.
Don M. Coleman. Aug 71, 171p SEL-TR-56, RADC-TR-71-162
Contract F30602-69-C-0214
Doctoral thesis.

Descriptors: *Quadratic programming, Optimization, *Programming(Computers), Algorithms, Set theory, Sequences, Dynamic programming, Linear programming, Multiple operation, Mathematical models, Pattern recognition, Theses.
Identifiers: Multiprogramming, Knapsack problem, Branch and bound method, Network flows, Graph theory.

In the design of many large scale systems it is frequently useful to formulate a number of the engineering problems as optimization problems in zero/one variables. Much effort is directed towards developing algorithms for solution of these problems which are readily programmed and do not require unreasonable amounts of computation time and storage. Linear programming has been one of the more successful techniques developed to deal with problems of this nature. For example, special algorithms have been developed for efficient solution of the classical transportation and assignment problems. In the document the author provides a method for solving a quadratic binary programming problem. The author shows this problem to have a wide range of applicability in both operations research and in computer systems design. (Author)

AD-729 646/CP PC **A04** MF **A01**
Naval Ship Research and Development Center Bethesda Md
VARAH1 and VARAH2: Two Eigensystem Programs for General Real Matrices
Final rept.
Donald A. Gignac. Feb 71, 67p Rept no. NSRDC-3549

Descriptors: *Programming(Computers), *Matrix algebra, Iterations, Transformations(Mathematics), Computer programs, Algorithms.
Identifiers: VARAH1 computer program, VARAH2 computer program, FORTRAN, Eigenvalues.

The VARAH1 program computes an approximate eigensystem for a general real matrix A. VARAH1 computes the eigenvalues by applying the double-step QR algorithm after A has been reduced to Hessenberg form H. The eigenvectors are found by computing the eigenvectors of H using inverse iteration and then transforming them into those of A by a change of basis. The VARAH2 program refines a given eigensystem for A and provides error bounds for the improved eigensystem using a procedure suggested by Wilkinson. VARAH1 and

VARAH2 are FORTRAN Extended adaptations (for the CDC 6700) of J. M. Varah's Extended ALGOL programs EIGENVALUESANDEIGENVECTORS and EIGENSYSTEMBOUNDS, respectively. (Author)

AD-729 753/CP PC **A06** MF **A01**
Rand Corp Santa Monica Calif
A Computer Program for Quadratic Mathematical Models to Be Used for Aircraft Design and Other Applications Involving Linear Constraints
L. Cutler, and D. S. Pass. Jun 71, 122p Rept no. R-516-PR
Contract F44620-67-C-0045

Descriptors: *Computer programs, *Quadratic programming, *Airplanes, Design, Mathematical models, Control sequences, Inventory control, Regression analysis, Linear programming, Least squares method.
Identifiers: FORTRAN 4 programming language, RS QPF4/360 computer program, Computer aided design, FORTRAN, Constraints.

The report contains a user's guide and listing of a FORTRAN 4 computer program, called RS QPF4/360, that minimizes a quadratic function of nonnegative variables subject to linear constraints. Originally developed to provide a smooth fit for segments of three-dimensional surfaces such as wings, fuselages, and ship hulls, the program applies generally to least squares fitting with linear constraints. It may be used for inventory control, missile tracking, weather, and reliability studies. A conversion of an earlier Rand program for use on the IBM 360/65, the double-precision code is all in core, with no time-consuming calls to peripheral equipment. The size of data storage can easily be set by the user. Problem size is usually limited by the size of the inverse of the basis, although data are packed in storage. Familiarity with the terminology used in the M series linear programming codes submitted to SHARE is assumed. (Author)

AD-729 890/CP PC **A09** MF **A01**
California Univ Los Angeles School of Engineering and Applied Science
Allocation of Multidimensional Unreliable Resources with a Stochastic Demand Regime
James R. Drugan. Jun 71, 185p UCLA-ENG-7132, AFOSR-TR-71-2418
Grant AF-AFOSR-699-67

Descriptors: *Dynamic programming, Stochastic processes, Decision theory, Partial differential equations, Set theory. Management engineering, Economics, Inventory control, Weapon systems, Computer programs, Numerical analysis, Optimization.
Identifiers: Allocation models, *Resource allocation, Computerized simulation, STOCHDYN computer program.

The report discusses the application of dynamic programming to systems which are multidimensional and stochastic. A discrete dynamic programming model is developed for this situation. Previous works in this area have been limited to systems which were either single dimensional, deterministic, or stationary. The dynamic programming approach is reviewed in this exposition first, for a single dimensional deterministic process, and then extended to the multidimensional stochastic case. The nature of this technique is also studied from the computational standpoint through the use of an example problem. (Author)

AD-729 896/CP PC **A13** MF **A01**
California Univ Los Angeles School of Engineering and Applied Science
Quasilinearization Solutions of Differential Games and Evaluation of Suboptimal Strategies
Rollyn Gene Graham, C. T. Leondes, E. B. Stear, and A. R. Stubberud. Jun 71, 281p UCLA-ENG-71-28, AFOSR-TR-71-2412
Contract F04701-70-C-0240, Grant AF-AFOSR-699-67

Descriptors: *Game theory, Optimization, *Guided missiles(Surface-to-air), Aircraft interception, *Supersonic planes, Evasion, Partial differential equations, Boundary value problems, Interception probabilities, Miss distance, Mathematical models, Decision theory, Numerical analysis, Computer programs.
Identifiers: *Differential games, Pursuit evasion games, Strategy, Quasilinearization, Multipoint boundary value problems, Euler-Lagrange equation, PEG2 computer program, PEG3 computer program.

The first-order necessary conditions for an optimal solution are derived for a very general problem in differential games. The problem statement includes terminal constraints, control and state variable inequality constraints, multiple arc solutions, and state variable discontinuities at specified and free corners. The problems of determining optimal solutions when the strategy of the opponent is known and when the strategy of the opponent is unknown and perhaps optimal are both treated. The comparison of the performances associated with these two cases provides a measure of the efficacy of a selected, suboptimal strategy. The first-order necessary conditions constitute a multipoint boundary value problem. The quasilinearization technique is extended to handle this problem, including the effects of control and state variable inequality constraints, multiple arc solutions, and discontinuities in the state and adjoint variables. This extension of quailinearization technique requires the linearization of the equations of motion, the Euler-Lagrange equations, the inequality constraint relationships, and the discontinuity conditions. The kth and (k-1)st iterations are then shown to be related by a complicated linear operator involving the inequality and discontinuity relationships. The kth iteration is constructed from the solution of the homogeneous and nonhomogeneous forms of the linear equations. (Author)

AD-729 936/CP PC **A03** MF **A01**
Systems Research Labs Inc Dayton Ohio
Mathematics and Programming for Environmental Medical Research
George C. Graff. Jan 69, 48p AMRL-TR-69-145
Contract F33615-67-C-1584

Descriptors: *Programming(Computers), Numerical analysis, *Respiratory system, Mathematical models, Ellipsoids, Integrals, Integration, Approximation(Mathematics), Computer programs, Data processing systems, Digital computers.

The report contains a mathematical method, suitable for digital computer implementation, for approximating the surface area of an ellipsoid. In addition, eight computer program write-ups are contained. The first of these programs computes and then both prints and punches on cards thirty-five pulmonary variables. The others calculate and graph standard statistics with options for smoothing and refining the data. (Author)

AD-729 947/CP PC **A06** MF **A01**
Systems Control Inc Palo Alto Calif
Dynamic Programming with Parallel Computers for Use in Air Force Applications
Final rept.
Robert E. Larson, Mark H. Richardson, and John L. Casti. Jul 71, 110p AFOSR-TR-71-2337
Contract F44620-70-C-0084

Descriptors: *Dynamic programming, Optimization, *Data processing systems, Problem solving, Air Force operations, Algorithms, Control sequences, Mathematical models, Decision making, Iterations, Integrals, Convergence, Adaptive control systems, Game theory, Inventory control, Numerical analysis.
Identifiers: Parallel processors, Graph theory, Control theory, Allocation models.

The report presents the results of a one-year study on the parallel aspects of the dynamic programming computational procedure. The report first discusses the various types of parallel computing machines expected to be available in the near future. The report then describes a number of new algorithms for implementing the dynamic programming computational procedure on these parallel computers. Several areas of applications for these new algorithms are presented. Abstracts of technical papers written under this contract, which contain the more significant results of this study, are also given. (Author)

AD-730 019/CP PC **A04** MF **A01**
Naval Weapons Center China Lake Calif
Optimal Regression Models for Multivariate Analysis (Factor Analysis)
Technical publication
D. R. Cruise. Aug 71, 56p Rept no. NWC-TP-5103

Descriptors: *Regression analysis, Mathematical models, *Multivariate analysis, Experimental data, Factor analysis, Computer programs, Interpolation, Combinatorial analysis, Matrix algebra.
Identifiers: Bivariate analysis, Trivariate analysis, Lattice design, FORTRAN.

Multivariate regression models are presented which are optimally responsive to measured variation in experimental data. Tabulated values of fitting functions are taken from selected eigenvectors of the cross-products matrix. Models are developed for bivariate and trivariate experiments. The lattice and non-lattice situations are examined. Numerical applications include the reduction, interpolation, and graphical presentation of experimental data. Statistical applications originated with the 'factor analysis' techniques employed in experimental psychology. (Author)

AD-730 086/CP PC **A04** MF **A01**
HRB-Singer Inc State College Pa
An 'Optimizer' for Use in Computer Simulation: Studies with a Prototype
Dennis E. Smith. Sep 71, 72p Rept no. HRB-4352.11-R-2
Contract N00014-69-C-0285

Descriptors: *Programming(Computers), Decision making, *Armed forces operations, Mathematical models, Decision theory, Optimization, Saddle point method, Data processing systems, Computer programs, Probability, Distribution functions, Interfaces, Numerical analysis, Simulation.
Identifiers: Computerized simulation, OPTIMIZER computer program.

Because of their extreme complexity, many military operations research problems cannot be examined analytically, but instead must be examined by means of computer simulation. However, the use of simulation in attempting to locate an optimum solution often degenerates into a trial-and-error process. The paper describes a study aimed at providing the simulation user with efficient methods of searching for optimum computer simulation solutions. (Author)

AD-730 307/CP PC **A02** MF **A01**
Ballistic Research Labs Aberdeen Proving Ground Md
On the Optimal Order of Scheduling Tests
Memorandum rept.
Barry H. Rodin. Jul 71, 12p Rept no. BRL-MR-2109

Descriptors: *Scheduling, Tests, *Army equipment, Tests, Sequences, Decision theory, Costs, Probability, Optimization, Computer programs.
Identifiers: FORTRAN, Risk.

The report considers a system S, composed of n components, which is deemed suitable only if all of its components are suitable. The components are to be tested sequentially until one of them is found to be unsuitable for they have all been tested. The test results are assumed to be statistically independent. The cost C(i) of testing component i and the probability p(i) of component i passing its test are to be estimated in advance. A theorem is proven giving the order in which the tests should be conducted so as to minimize the expected cost of testing. (Author)

AD-730 704/CP PC **A03** MF **A01**
Texas Univ Austin Center for Cybernetic Studies

A Comparison of Computation Times for Various Starting Procedures, Basis Change Criteria, and Solution Algorithms for Distribution Problems
Research rept.
D. Karney, D. Klingman, Fred Glover, and A. Napier. May 71, 32p Rept no. CS-44
Contract N00014-67-A-0126-0008, N00014-67-A-0126-0009
Prepared in cooperation with Colorado Univ., Boulder and Continental Oil Co., Ponca City, Okla.

Descriptors: *Linear programming, Algorithms, *Programming(Computers), Distribution functions, Simplex method, Mathematical models, Transportation, Optimization.
Identifiers: Duality theory, Transportation models.

New methods for accelerating the determination of basis trees and dual evaluators for distribution problems are compared with standard solution procedures in a computational study of a wide range of distribution problems of varying sizes and densities. Computer programs utilizing the new methods are tested for computational efficiency in an experiment involving four solution techniques, four start algorithms, and four change of basis criteria, thus affording an empirical determination not only of the merits of various procedures in isolation but also of their effectiveness in combination. The study discloses that the most efficient solution procedure arises by coupling a primal transportation algorithm (embodying the accelerated updating and pricing methods) with a version of the Row Minimum start rule and a modified first negative evaluator rule. The resulting method was found to improve upon the efficiency of general purpose algorithms (taken from standard computer packages) by a factor of 50 or better, and also improved upon a streamlined version of the SHARE out-of-kilter code by a factor of 3. The method's median solution time for solving 175 x 175 distribution problems on a CDC 6600 computer was 11.4 seconds with a range of 9 to 13 seconds. (Author)

AD-731 024/CP PC **A04** MF **A01**
Naval Ordnance Lab White Oak Md
Fast Fourier Transform Programs for the Digital Simulator and Computer (DISAC)
Curtis A. Shively. 8 Sep 71, 70p Rept no. NOLTR-71-149

Descriptors: *Integral transforms, *Computer programs, *Fourier analysis, Computer programs, Integral transforms, Control sequences, Subroutines, Mapping(Transformations), Sampling, Series.
Identifiers: Fast Fourier transform, Fourier transformation, Digital simulation, Signal processing, Fourier series.

For processing signals in the spectral domain, it is often useful to program a digital computer to compute the forward or inverse Discrete Fourier Transform (DFT) of N sample values of a complex time or frequency function. This report describes a computer program which implements the Fast Fourier Transform algorithm to give a reduction in DFT computation time by a factor of 2N/log of N to the base 2 when N is a power of two. Other properties of the DFT are used to further reduce computation time and memory storage required when the time samples are real. Also described are an auxiliary program for generating the complex exponentials needed to compute the DFT, and a subroutine for converting the complex DFT coefficients to a magnitude-phase representation. (Author)

AD-731 137/CP PC **A06** MF **A01**
Illinois Univ Savoy Aviation Research Lab
General Computer Program for Response Surface Methodology Analyses
Christine Clark, Robert C. Williges, and Samuel G. Carmer. May 71, 108p ARL-71-8/AFOSR-71-1, AFOSR-TR-71-2597
Contract F44620-70-C-0105

Descriptors: *Programming(Computers), *Statistical analysis, Computer programs, Combinatorial analysis, Regression analysis, Analysis of variance, Human engineering, Experimental design, Correlation techniques.
Identifiers: *Response surface analysis, Block design, FORTRAN 4 programming language, FORTRAN.

The report describes a computer program which was developed to provide statistical analyses of central-composite Response Surface Methodology designs. Details are given as to the preparation of the card deck. In addition, a complete flowchart and source list is presented. Examples of various types of analyses are presented. These examples include central-composite designs which are either blocked or unblocked and have multiple observations at only the center point. Also included are examples of central-composite designs with multiple observations on the same subject or different subjects at each experimental point. (Author)

AD-731 220/CP PC **A14** MF **A01**
Michigan Univ Ann Arbor Systems Engineering Lab
Solution of Markov Renewal Decision Processes with Application to Computer System Scheduling
Technical rept.
John W. Boyse. Sep 71, 303p SEL-TR-52, RADC-TR-71-180
Contract F30602-69-C-0214

Descriptors: *Data processing systems, Scheduling, *Programming(Computers), Multiple operation, Queueing theory, Stochastic processes, Mathematical models, Computer storage devices, Input-output devices, Time sharing, Decision making, Differential equations, Matrix algebra, Numerical analysis.
Identifiers: *Multiprogramming, Markov processes, Renewal processes, Central processing units.

The paper pursues the theoretical development and application of Markov renewal decision processes in the design of efficient multiprogrammed computer systems. A Markov process is used to model the software design of multiprogrammed computer systems; namely, the problem of assignment of central processors and main memory to those jobs requesting them. Application of the optimization method to this model allows the determination of scheduling rules which maximize throughput. Parameters which may be varied in the model include the size of main memory relative to the sizes of individual tasks. the execution characteristics of tasks themselves, the number of processors, and the fraction of its total memory requirement each task may share with other tasks. Results for a range of values of parameters are presented which compare the throughput possible under optimal scheduling rules under a good heuristic scheduling rule. (Author)

AD-731 391/CP PC **A11** MF **A01**
Research Analysis Corp Mclean Va
A Guide to SUMT-Version 4: The Computer Program Implementing the Sequential Unconstrained Minimization Technique for Nonlinear Programming
W. Charles Mylander, Raymond L. Holmes, and Garth P. McCormick. Oct 71, 230p Rept no. RAC-P-63

Descriptors: *Nonlinear programming, Optimization, *Computer programs, Nonlinear programming, Subroutines, Sequences, Approximation(Mathematics), Convex sets, Convergence, Input-output devices, Numerical analysis.
Identifiers: SUMT 4 computer program, FORTRAN 4 programming language, FORTRAN, Penalty functions.

The mathematical programming problem--minimize f(x) subject to g sub j (x) $>$ or $=$ 0, for j $=$ 1,2,...,m, and h sub j (x) $=$ 0 for j $=$ m $+$ 1,...,m $+$ p, where f, g sub j, and h sub j may be nonlinear functions--is solved by solving a sequence of unconstrained minimization problems. The algorithm that is implemented by the code described in this document is discussed in another paper. The mixed interior-exterior penalty function is used and any of several algorithms can be specified for minimizing the penalty function. The program is coded in FORTRAN IV. (Author)

AD-731 397/CP PC **A03** MF **A01**
Harvard Univ Cambridge Mass Dept of Statistics
One- and Two-Stage Models for Comparing an Experimental Treatment with a Standard
Technical rept.
Allan P. Donner. 8 Oct 71, 27p Rept no. TR-36
Contract N00014-67-A-0298-0017

Descriptors: *Therapy, *Statistical analysis, Sequential analysis, Correlation techniques, Statistical tests, Probability, Distribution functions, Computer programs.
Identifiers: ALGOL.

Optimal one- and two-stage plans are developed for selecting one of two medical treatments, an experimental treatment A or a standard treatment B. The response to treatment is normally distributed with unknwon mean mu sub A or mu sub B and known variance sigma squared. It is assumed mu sub A $>$ or $=$ mu sub B but that treatment A is worthwhile adopting only if mu sub A - mu sub B $>$ or $=$ a, where a is fixed. The only cost considered is the ethical one of treating a patient with the 'wrong' treatment. Out of a total of N patients with the disease in question, a fraction 2P of them is to be placed in a clinical trial comparing the two treatments, with the 'winning' treatment to be given to the remaining N(1-2P) patients. Optimal values of P are found for both a one-stage and a two-stage plan, with the latter showing a modest improvement in expected net gain. The case in which mu sub B is known is also considered, and the resultant improvement in expected net gain over the case mu sub B unknown is found to moderate for a one-stage trial. (Author)

AD-732 005/CP PC **A09** MF **A01**
Massachusetts Inst of Tech Cambridge
Evaluation of Definite Integrals by Symbolic Manipulation
Doctoral thesis
Paul S-H. Wang. Oct 71, 190p Rept no. MAC-TR-92
Contract N00014-70-A-0362-0001, N00014-70-A-0362-0002
Includes errata sheet dated Nov 71.

Descriptors: *Programming(Computers), Integral equations, *Integral equations, Integration, Analytic functions, Asymptotic series, Saddle point method, Polynomials, Complex variables, Numerical analysis, Computer programs, Theses.
Identifiers: MAC project, WADERER computer program, DELIMITER computer program.

A heuristic computer program for the evaluation of real definite integrals of elementary functions is described. This program, called WANDERER (WANg's DEfinite integRal EvaluatoR), evaluates many proper and improper integrals. The improper integrals may have a finite or infinite range of integration. Evaluation by contour integration and residue theory is among the methods used. A program called DELIMITER (DEfinitive LIMIT EvaluatoR) is used for the limit computations needed in evaluating some definite integrals. DELIMITER is a heuristic program written for computing limits of real or complex analytic functions. For real functions of a real variable, one-sided as well as two-sided limits can be computed. WANDERER and DELIMITER have been implemented in the MACSYMA system, a symbolic and algebraic manipulation system being developed at Project MAC, MIT. A typical problem in applied mathematics, namely asymptotic analysis of a definite integral, is solved using MACSYMA to demonstrate the usefulness of such a system and the facilities provided by WANDERER. (Author)

AD-732 409/CP PC **A05** MF **A01**
Army Missile Command Redstone Arsenal Ala Aeroballistics Directorate
A Computer Program for the Probability of Obtaining S Successes in a Success/Failure Test with Different Conditions
Technical rept.
Nancy R. Rich. 2 Jun 71, 94p Rept no. RD-TR-71-11

Descriptors: *Programming(Computers), Probability density functions, *Weapon systems, Reliability, Computer programs, Distribution functions, Monte

Carlo method, Random variables, Sampling, Probability, Curve fitting, Tables, Tests, Performance(Engineering).
Identifiers: PSST computer program.

The document contains the theoretical development and user's manual for the PSST digital computer program. This program estimates a distribution function for the probability of obtaining at least S prime successes in a test with N trials under various conditions. The input to the program includes a distribution function of the probability of success in a single trial under each condition. The program was written for a study of the probability that a certain weapon system would pass the scheduled engineering test and can be used for similar studies. This document also describes a digital computer program that combines component data into an estimate of system performance. (Author)

AD-732 449/CP PC **A05** MF **A01**
Naval Ammunition Depot Crane Ind Quality Evaluation and Engineering Lab
Multivariate Analysis of Variance
John G. Gilley. Sep 71, 86p Rept no. QEEL-TR-13

Descriptors: *Multivariate analysis, Population(Mathematics), *Analysis of variance, Statistical tests, Distribution functions, Confidence limits, Sampling, Matrix algebra, Computer programs.
Identifiers: Degrees of freedom.

Multivariate procedures are explained in the report in terms of corresponding univariate procedures. Multivariate extensions of the analysis of variance are given. A computer program listing of a two-way multivariate analysis of variance and an actual surveillance problem is included. A comparison was made between the results of the analysis as it was run using separate analysis of variance tests and the results of th multivariate analysis of variance. The material presented in this report is largely based on a class in Multivariate Analysis given at the Unitersity of Tennessee by Dr. Clyde Y. Kramer of Virginia Polytechnic Institute. (Author)

AD-732 834/CP PC **A03** MF **A01**
Army Missile Command Redstone Arsenal Ala Aeroballistics Directorate
Correlation of Experimental Aerodynamic Coefficients on the Basis of Curve Fitting in the Three-Dimensional Cartesian alpha, (C sub N), (C sub m) Space
Technical rept.
Helmut H. Korst, and Alva L. Addy. 13 Jul 71, 34p Rept no. RD-TR-71-16

Descriptors: *Curve fitting, Least squares method, *Aerodynamic characteristics, Curve fitting, Partial differential equations, Matrix algebra, Polynomials, Iterative methods, Computer programs.
Identifiers: COEFIT computer program, FORTRAN 4 programming language, FORTRAN.

A method is presented for curve fitting experimental aerodynamic normal-force and pitching-moment coefficient data as a function of angle of attack. The method is based on the postulation of the existence of a single (C sub N)-(C sub m)-alpha space curve that has a common offset value of the angle of attack for which the normal-force and pitching-moment coefficients simultaneously vanish. The curve fits in the (C sub N)-(alpha) and (C sub m)-(alpha) planes are based on minimizing the squared error between the fitted curves and the experimental data by proper selection of the curve-fit coefficients and the common angle-of-attack offset value. (Author)

AD-733 069/CP PC **A04** MF **A01**
Naval Ship Research and Development Center Bethesda Md
Documentation of XIRE - A Multivariable Tape Regression Analysis Program with Rule-of-Thumb Guides for Interpretation of Results by Nonstatisticians
Final rept.
Marcel L. Salive, and Richard J. Langley. Oct 71, 74p Rept no. NSRDC-3702

Descriptors: *Programming(Computers), *Regression analysis, Statistical tests, Control sequences, Computer storage devices, Input-output devices, Random variables, Computer programs, Correlation techniques.
Identifiers: XIRE computer program, FORTRAN 4 programming language, FORTRAN, Standard deviation.

XIRE is a multivariable regression analysis program which solves for correlation coefficients in an equation of the form Y = b(0) + b(1)x(2) + ...b(59)x(59) where Y, x(1),x(2), ...x(59) are terms consisting of variables which may be transformed in a variety of ways. Each x(i) may be a complex term built up by a combination of several variables and constants which may be transformed and/or raised to an exponential power. The equations may be made to fit theoretical or known relationships, be used to provide an empirical fit giving useful parametric equations expression the relative effect of several independent variables on some property (dependent variable), and be used to provide a method of predicting the most likely value of some property or structure given a set of known conditions. Using tape storage to accept an unlimited number of data points with up to 60 different input variables, the program will search for aberrant data values, discard them, and then complete the correlation. Double precision routines are used for matrix calculations in order to minimize the possibility of creating an apparently singular matrix. Output consists of the variables analyzed by name, their regression coefficients, and a value of each regression coefficient with a t distribution table to evaluate the confidence interval for a given regression coefficient. The program calculates the mean and standard deviation of the regression. It also back-calculates from the original data and compares the calculated value of the dependent variable to its measured value and gives confidence intervals on each point.

AD-733 073/CP PC **A04** MF **A01**
Stanford Univ Calif Dept of Computer Science
An Algorithm for the Generalized Matrix Eigenvalue Problem Ax equals lambda Bx
Technical rept.
Cleve B. Moler, and G. W. Stewart. Aug 71, 54p Rept no. STAN-CS-232-71
Contract N00014-67-A-0112-0029, Grant NSF-GJ-1158
Prepared in cooperation with Texas Univ., Austin. Center for Numerical Analysis, Grant NSF-GP-23655, Rept. no. CNA-32.

Descriptors: *Matrix algebra, Algorithms, Vector spaces, Sequences, Iterative methods, Computer programs.
Identifiers: Eigenvalues, FORTRAN, Eigenvectors, Hessenberg matrices.

A new method, called the QZ algorithm, is presented for the solution of the matrix eigenvalue problem Ax = lambda Bx with general square matrices A and B. Particular attention is paid to the degeneracies which result when B is singular. No inversions of B or its submartices are used. The algorithm is a generalization of the QR algorithm, and reduces to it when B = I. A Fortran program and some illustrative examples are included. (Author)

AD-733 183/CP PC **A03** MF **A01**
Naval Postgraduate School Monterey Calif
Adaptation and Validation of a Computer Ranking for Partially Ordered Data
Master's thesis
Richard Woodie Mister. Sep 71, 50p

Descriptors: *Statistical tests, Correlation techniques, *Decision theory, Probability, Matrix algebra, Distribution functions, Computer programs, Naval research, Curve fitting, Iterative methods, Theses.
Identifiers: Ranking, Order statistics.

In 1957 L. R. Ford, Jr., developed a procedure that would produce a rank-order of objects from subjective judgments. Standard procedures usually require that the number of comparisons between any given pair of objects be equal to the number between any other pair. This method does not require any specific number of comparisons between pairs, and it allows that there be missing data. A computer program was developed utilizing Ford's technique. This study adapted the program for use on the IBM 360/67 and evaluated the validity of the program and model which appeared good. Applications for the use of such a program in the Navy were cited. (Author)

AD-733 217/CP PC **A03** MF **A01**
Naval Postgraduate School Monterey Calif
Alternating Renewal Process with Exponentially Distributed Time to Failure. Bounds with Precision
Master's thesis
Tor Mikal Nikolaisen. Sep 71, 37p

Descriptors: *Replacement theory, Statistical processes, Integral transforms, Exponential functions, Probability density functions, Approximation(Mathematics), Reliability, Stochastic processes, Computer programs, Theses.
Identifiers: *Renewal processes, Gamma function, Laplace transformation, Renewal theory, FORTRAN 4 programming language, FORTRAN, Weibull density functions.

The paper considers an alternating renewal process with time to failure being distributed exponential (lambda), and with a general distribution for time to repair. Bounds and the precision of the bounds for the availability function were obtained. A computer program was written to solve for the availability function and some other quantities when the down distribution was a gamma (alpha, beta), alpha integer. The availability function with down distribution being a mixture of gamma-functions is considered. (Author)

AD-733 220/CP PC **A04** MF **A01**
Naval Postgraduate School Monterey Calif
A Comparison of Solutions of a Linear Homogeneous Self-Adjoint Differential Equation with Variable Coefficients by the Newton, Stodola and Rayleigh-Ritz Methods
Master's thesis
William Kent Terrell. Sep 71, 55p

Descriptors: *Partial differential equations, Integration, Operators(Mathematics), Matrix algebra, Approximation(Mathematics), Calculus of variations, Integrals, Numerical analysis, Computer programs, Theses.
Identifiers: Eigenvalues, Numerical integration, Newton method, Spline functions, Rayleigh-Ritz method, Stodala method.

Three techniques for finding the eigenvalues and eigenfunctions are investigated. A typical problem involves a linear homogeneous differential equation with variable coefficients of the form P(x) y double primed (x) + P primed (x) y primed (x) + omega (sup 2) M(x) = O. The functions P(x) and M(x) are functions which are positive, or have at most isolated zeroes on the fundamental interval (O,L); omega is a parameter. Appropriate end conditions are specified so that the problem is self-adjoint. The three methods are: Newton's method, Stodola's method, and the Rayleigh-Ritz method. The methods are derived and a computer solution by each method is included in the paper. A second problem involving Bessel's equation of order zero is solved using each method and a comparison of the eigenvalues and eigenfunctions is made with tabulated values. The results indicate that Newton's method is to be preferred usually. (Author)

AD-733 237/CP PC **A04** MF **A01**
Naval Postgraduate School Monterey Calif
A Repairable Item Inventory System Using Dynamic Programming and Markov Processes
Master's thesis
James Alfred Biggins. Sep 71, 62p

Descriptors: *Inventory control, Mathematical models, *Dynamic programming, Algorithms, Stochastic processes, Matrix algebra, Management planning, Decision theory, Costs, Stock level control, Maintenance, Computer programs, Optimization, Theses.
Identifiers: Markov processes, Cost functions.

The thesis develops an analytical model of a repairable item inventory system. The system consisted of a depot that repaired failed units according to some repair policy and stocked ready-for-issue units in support of a finite number of customers. A least-cost repair policy and stock level was determined by use of a computer program which is included as an appendix. (Author)

AD-733 436/CP PC **A09** MF **A01**
Naval Postgraduate School Monterey Calif
Tables of Eigenvalues and Eigenfunctions of the Orr-Sommerfeld Equation for Plane Poiseuille Flows
Technical rept.
R. H. Gawain, and W. H. Clark. 10 Sep 71, 185p Rept no. NPS-57GN71092A

Descriptors: *Fluid flow, Equations of motion, *Partial differential equations, Matrix algebra, Two-dimensional flow, Incompressible flow, Viscosity, Laminar flow, Integration, Numerical analysis, Curve fitting, Tables, Computer programs.
Identifiers: Eigenvalues, Eigenvectors, *Poseville flow, *Orr-Sommerfeld equation, Numerical integration, FORTRAN 4 programming language, FORTRAN.

In the report the authors present a numerical technique for computing the eigenvalues and eigenfunctions of the Orr-Sommerfeld equation for infinitesimal disturbances in plane Poiseuille flows. For the case alpha = 1.0, Rsube = 6667 the eigenvalues, beta sub Nm, (n = 1,2,3,4 m = 1,2,...199) and eigenfunctions, phi sub nm(y), (n = 1,2,3,4 m = 1,2,...8) are presented in tabular and graphical form. In addition the function, chi sub nm(y), which is orthogonal to phi sub nm(y), over the interval -1 <or - y < or - plus or minus 1 is tabulated. In a previous report (Gawain and Clark)1971) it was shown that these eigenfunctions can be extremely useful in describing certain aspects of the nonlinear mechanics of wave disturbances in plane Poiseuille flows. It is hoped that the present report will serve both as a complement to the previously mentioned report and as a useful reference for similar future investigations. (Author)

AD-733 899/CP PC **A11** MF **A01**
Illinois Univ Urbana Coordinated Science Lab
Singular Perturbation of the Linear State Regulator
Doctoral thesis
Richard Alan Yackel. Sep 71, 241p Rept nos. R-532, UILU-ENG-71-2235
Contract DAAB07-67-C-0199

Descriptors: *Adaptive control systems, Mathematical models, *Nonlinear differential equations, Initial value problems, Linear systems, Matrix algebra, Perturbation theory, Approximation(Mathematics), Asymptotic series, Integration, Numerical analysis, Optimization, Theses, Computer programs.
Identifiers: *Control theory, Automatic control, Riccati equation, Time invariant systems, Time varying systems, Regulators.

The presently established Singular Perturbation Theory for nonlinear differential equations is used in this thesis to find an approximate solution of the linear regulator problem in optimal control. The transient behavior of certain fast state variables is neglected by introducing an artificial parameter, lambda, which multiplies the derivatives of these variables in the state equations. This parameter is then set to zero at an appropriate point in the solution of the problem to reduce the computational time and storage requirements. (Author)

AD-733 935/CP PC **A04** MF **A01**
Army Combat Developments Command Systems Analysis Group Fort Belvoir Va
Analysis of Random Numbers from Four Uniform Random Number Generators
Technical rept.
Carl B. Bates, and Janice A. Zirkle. Aug 71, 61p Rept no. TR-4-71

Descriptors: *Numerical analysis, Random variables, Stochastic processes, Probability density functions, Confidence limits, Statistical tests, Computer programs, Simulation.
Identifiers: Chi square test, FORTRAN, *Random numbers, Computerized simulation, FORTRAN.

The statistical properties of the numbers generated by four uniform random number generators are investigated. The properties investigated are the uniformity and the randomness of the sequence generated by each number generator. The Chi-square test is applied to the frequency distribution of the generated numbers to test for uniformity. Tuns tests and the serial test are used to test for randomness. The testing is performed on a sequence of 50,000 numbers generated by each uniform random number generator. (Author)

AD-734 403/CP PC **A03** MF **A01**
Research Analysis Corp Mclean Va
Operation Capability Description. European Theater Network Analysis Model (ETNAM)
Final rept.
John E. Cremeans. Jan 71, 48p
Contract DCA100-70-C-0039
See also report dated Jan 71, AD-734 404.

Descriptors: *Armed Forces transportation, Mobility, *Programming(Computers), Mobilization, *Linear programming, Algorithms, Networks, Mathematical models, Multiple operation, Feasibility studies, Data processing systems, Simplex method, Europe.
Identifiers: ETNAM(European Theater Network Analysis Model), Transportation models, European theater network analysis model, Resource allocation, Network analysis theory, Network flows.

The document describes the European Theater Network Analysis Model (ETNAM), its potential applications and the basic data required to operate it. It is intended to provide management level information about the model and to provide a basis for a decision to use or not to use the model in specific mobility studies. ETNAM is an optimizing model that uses a special form of the simplex algorithm of linear programming and the shortest chain algorithm of graph theory to select routes and allocate resources to those routes so as to maximize flow, minimize cost or minimize time subject to the constraints of the network and the available resources. (Author)

AD-734 405/CP PC **A08** MF **A01**
Research Analysis Corp Mclean Va
System Description. European Theater Network Analysis Model (ETNAM). Volume III. Analytical Manual
Final rept.
John E. Cremeans, Henry S. Weigel, Dorothy L. Ray, and John T. Sincavage. Jan 71, 168p
Contract DCA100-70-C-0039
See also Volume 1, AD-734 404 and Volume 4, Part 1, AD-734 406.

Descriptors: *Armed Forces transportation, Mobility, *Programming(Computers), Instruction manuals, *Linear programming, Algorithms, Input-output devices, Mobilization, Mathematical models, Networks, Multiple operation, Simplex method, Control sequences, Optimization, Europe.
Identifiers: ETNAM(European Theater Network Analysis Model), European theater network analysis model, Transportation models, Resource allocation, Network flows, Network analysis theory.

The document provides a basic, non-mathematical introduction to the ETNAM model and the associated system of computer programs. It provides a basic guide to the preparation of input data and the operation of the system of computer programs from an analytical point of view. It is intended to serve the military analyst as a basic introduction and guide to the application of the ETNAM model to mobility problems. ETNAM is an optimizing model that uses a special form of the simplex algorithm of linear programming and the shortest chain algorithm of graph theory to select routes and allocate resources to those routes so as to minimize cost, minimize time or maximize flow subject to the constraints of the network and the available resources. (Author)

AD-734 663/CP PC **A07** MF **A01**
Naval Electronics Lab Center San Diego Calif
Mathematical Programming as an Aid to Engineering Design
Research and developrnent rept. Jul 68-Mar 70
D. C. McCall. 11 Aug 71, 131p Rept no. NELC-TR-1778

Descriptors: *Mathematical programming, Algorithms, *Programming(Computers), Mathematical models, Linear programming, Nonlinear programming, Convex sets, Matrix algebra, Transformations(Mathematics), Approximation(Mathematics), Problem solving, Computer programs, Design, Optimization, Numerical analysis.
Identifiers: Constraints, Convex programming, Duality theory, Nonconvex programming, Integer programming, SUMT computer code, FORTRAN.

The report is a user's guide to available mathematical programming (MP) computer codes and to NELC's capabilities in numerically solving MP problems. It defines the general MP problem; lists and evaluates the MP codes operational on the NELC/IBM 360/65 computers; and provides guidelines for modifying the MP problem when, in its first form, it is cumbersome; or there is not information enough to start computation; or the available codes do not yield all the needed information. (Author)

AD-734 837/CP PC **A02** MF **A01**
Picatinny Arsenal Dover N J
A Computer Program that Computes and Draws an Exact Operating Characteristic Curve Using the Hypergeometric Probability Distribution
Technical rept.
Donald C. Rappaport. Nov 71, 19p Rept no. PA-TR-4293

Descriptors: *Computer programs, Curve fitting, *Quality control, Statistical analysis, *Reliability, Statistical analysis, Hypergeometric functions, Probability density functions, Numerical analysis, Acceptability.
Identifiers: *Hypergeometric probability distribution functions, FORTRAN.

A computer program was developed which uses the Hypergeometric Probability Distribution in computing and plotting percent defective vs. 10 important probability of acceptance points (.99, .975, .95, .90, .75, .50, .25, .10 .05 and .01). (Author)

AD-734 865/CP PC **A05** MF **A01**
Naval Postgraduate School Monterey Calif
A Comparison of Short-Term Forecasting Models
Master's thesis
Ralph Eugene Hayes. Sep 71, 95p

Descriptors: *Mathematical prediction, *Time series analysis, Least squares method, Mathematical models, Stochastic processes, Analysis of variance, Regression analysis, Random variables, Economics, Logistics, Management planning, Computer programs, Theses.
Identifiers: Random processes, Exponential smoothing, Forecasting models, FORTRAN.

Seven short-term forecasting models, two using least-squares estimation methods and five employing variations of the exponentially weighted moving average method, are compared in their relative ability to produce minimum error variance forecasts for seven simulated time series. Each series was generated to enable one of the forecast models to be the least squared error predictor. A comparison methodology is developed which facilitates forecast model performance through the measurement of model specification errors. A computer program is presented which may be modified to accept real time series and which permits the forecast models to be ranked in order of their relative specification error. (AUTHOR)

AD-734 971/CP PC **A03** MF **A01**
Naval Postgraduate School Monterey Calif

A Modified Kolomogorov-Smirnov Test Applicable to Censored Samples
Master's thesis
Teddy George Davidson. Sep 71, 43p

Descriptors: *Statistical tests, Sampling, Confidence limits, Distribution functions, Population(Mathematics), Random variables, Computer programs, Tables, Theses.
Identifiers: *Kolomogorov-Smirnov test, Hypotheses.

Herein is presented a derivation and computational formulation for a modified Kolomogorov-Smirnov test. This test extends the hypothesis testing and confidence limits advantages of the Kolomogorov-Smirnov test to data which is censored beyond a predetermined number of observations. A listing of the computer program used in the calculations of significance levels and the resulting significance levels for specified parameter values for the mofified test are included. (Author)

AD-734 979/CP PC **A07** MF **A01**
Naval Postgraduate School Monterey Calif
The Effect of Error Non-Normality on the Power of Parametric and Non-Parametric ANOV Tests
Master's thesis
Robert William Germany Jones. Sep 71, 127p

Descriptors: *Statistical tests, *Analysis of variance, Distribution functions, Curve fitting, Correlation techniques, Errors, Computer programs, Theses, Power.
Identifiers: Nonparametric statistics, F test, Chi square test, Computerized simulation.

The purpose of the thesis is to determine the power relationship, through computer simulation, between the parametric ANOV and non-parametric Wilson tests under controlled conditions of error non-normality. (Author)

AD-735 129/CP PC **A08** MF **A01**
Georgia Univ Athens Dept of Statistics and Computer Science
Configuration and Classification of Clusters in n-Dimensions
Technical rept.
Surendra J. Trivedi, and Rolf Bargmann. Dec 71, 163p Rept nos. TR-75, THEMIS-UGA-17
Contract N00014-69-A-0423

Descriptors: *Multivariate analysis, Sampling, *Factor analysis, Experimental data, Matrix algebra, Random variables, Computer programs, Graphics, Display systems, Distribution functions, Transformations(Mathematics), Probability.
Identifiers: *Cluster analysis, Interactive computer graphics, CLUSTR computer program, ELLIPSE computer program, FORTRAN.

Many experiments involve measuring a number of response variables simultaneously. As a result of giving one stimulus to an experimental unit, what the author obtains is not just one response but several responses. In statistical language, one deals with a multivariate situation as opposed to univariate situations. Usually, many stimuli, called factors, are considered at many levels in the same experiment. Many statistical techniques are available to analyse this type of data and to draw conclusions therefrom. The present work considers one such technique, the identification of subgroups of individuals on the basis of responses, i.e., a special case of cluster analysis. Many different algorithms proposed for detecting clusters have been reviewed. These fall into two classes-- those which detect clusters of variables--factor analysis--and those which detect clusters of experimental units--cluster analysis. What the author has done in the present work lies inbetween these two techniques. (Author)

AD-735 140/CP PC **A02** MF **A01**
Naval Postgraduate School Monterey Calif
System Service Output, with Application to Multiprogramming
Technical rept.
Donald P. Gaver. Sep 71, 19p Rept no. NPS-55GV71091A

Descriptors: *Queueing theory, Programming(Computers), *Programming(Computers), Multiple operation, Stochastic processes, Input-output devices, Mathematical models, Random variables, Distribution functions.
Identifiers: Multiprogramming, M/G/1 queue.

The stochastic properties of the output of a multiprogramming computer system are studied by means of a simple cyclic queueing model. It is shown that output is asymptotically normally distributed. The parameters are determined by considering a cumulative stochastic process that depends upon busy period properties; the latter may be recursively determined. Numerical examples are provided. (Author)

AD-735 144/CP PC **A08** MF **A01**
Georgia Univ Athens Dept of Statistics and Computer Science
Pseudo Random Number Generators for Statistical Applications
Technical rept.
Lovick Edward III Cannon. Aug 71, 165p Rept nos. TR-69, THEMIS-UGA-15
Contract N00014-69-A-0423

Descriptors: *Statistical analysis, Random variables, *Programming(Computers), Statistical analysis, Statistical tests, Distribution functions, Probability density functions, Sampling, Computer storage devices, Computer programs.
Identifiers: *Random number generators, Themis project, Random numbers, Gamma function, Probability distribution functions, *Pseudorandom numbers.

Pseudo random number generating programs coded in machine language for the IBM 360/65 computer have been prepared for producing random values from the normal, exponential, and gamma distributions as well as from any discrete probability distribution. The schemes are based largely on combinations of sophisticated techniques first suggested by Marsaglia. The distributions simulated are exact within the word size of the computer and average production time per number is very short, e.g. 10 to 40 microseconds depending upon the particular distribution. (Author)

AD-735 309/CP PC **A05** MF **A01**
Naval Postgraduate School Monterey Calif
An Algorithm for the Solution of Concave-Convex Games
Master's thesis
Lee Fredric Gunn, and Peter Tocha. Sep 71, 78p

Descriptors: *Game theory, Algorithms, *Antisubmarine warfare, Mathematical models, Convex sets, Minimax technique, Matrix algebra, Partial differential equations, Computer programs, Mission profiles, Theses.
Identifiers: Allocation models, Resource allocation, Concave convex games, FORTRAN, FORTRAN 4 programming language.

The thesis discusses the solution of concave-convex games. An algorithm is developed, a computer program written and applied to an anti-submarine warfare force allocation problem as an illustration. Techniques for handling concave-convex problems in high dimensions are included. (Author)

AD-735 406/CP PC **A03** MF **A01**
National Bureau of Standards Washington D C
A Search and Rescue Simulation Model for the United States Coast Guard. Volume I. Executive Level Documentation
R. T. Penn, Jr, and W. G. Leight. 18 Jun 71, 34p Rept no. NBS-10430
See also Volume 2, AD-735 407.

Descriptors: *Coast Guard, Operational readiness, *Sea rescues, Mathematical models, Management planning, Decision making, Queueing theory, Stochastic processes, Programming(Computers), Statistical analysis, Simulation.
Identifiers: SARSIM(Search and Rescue Simulation Model), Search and rescue simulation model, Computerized simulation, Resource allocation.

An inter-disciplinary team, comprised of members of the staff of the Technical Analysis Division of the Bureau of Standards and representatives of the U.S. Coast Guard, has developed a Search and Rescue Simulation Model (SARSIM). Actual or projected values are used for such parameters as location of Coast Guard stations; types, deployments and capabilities of resources; manning levels; case loads; and resource assignment policies. Computer runs of the model can then provide rapid and realistic simulations of the Search and Rescue (SAR) process, supplying as output appraisals of the degree to which satisfactory service is provided, utilization of individual resources and resource types, average length of time for cases awaiting service, etc. SARSIM thus represents a powerful managerial tool with which Coast Guard planners and decision makers can economically and expeditiously explore the likely effects of proposed major changes in allocation or mode of operation. (Author)

AD-735 407/CP PC **A09** MF **A01**
National Bureau of Standards Washington D C
A Search and Rescue Simulation Model for the United States Coast Guard. Volume II. Analyst Level Documentation
S. S. Karp, and M. D. Maltese. Jun 71, 178p
Contract NBS-10431
Errata sheet inserted. See also Volume 1, AD-735 406.

Descriptors: *Coast Guard, Operational readiness, *Sea rescues, Mathematical models, *Programming(Computers), Instruction manuals, Management planning, Decision making, Queueing theory, Subroutines, Data processing systems, Input-output devices, Monte Carlo method, Scheduling, Simulation.
Identifiers: SARSIM(Search and Rescue Simulation Model), Search and rescue simulation model, Computerized simulation, Resource allocation.

SARSIM is a highly flexible, user-oriented model. It simulates Coast Guard response to an input caseload scenario, i.e., people and/or property in distress. The automatic summary output from the model (e.g., response times, resource utilization statistics, etc.) gives the user considerable insight for judging the effectiveness of the SAR system with regard to each input scenario. The user if offered a variety of modes in which to operate the model. For example, he can prepare, automatically, a multitude of clinet demand scenarios. He can perturb the SAR resource inventory, i.e., vary the number and classes of resources, their physical capabilities, their deployment (location), and manning levels. He may also choose to exercise the model with different server disciplines (resource assignment schemata). In addition, the user can supply criteria to be applied to the simulated case history output for additional optional analysis. (Author)

AD-735 413/CP PC **A05** MF **A01**
National Bureau of Standards Washington D C
A Search and Rescue Simulation Model for the United States Coast Guard. Volume III. Programmer Level Documentation for 'Preprocessor'
S. S. Karp, L. K. Cummings, M. D. Maltese, and A. L. Weber. Jun 71, 93p Rept no. NBS-10432
Errata sheet inserted. See also Volume 2, AD-735 407 and Volume 4, AD-735 414.

Descriptors: *Coast Guard, Operational readiness, *Sea rescues, Mathematical models, *Programming(Computers), Instruction manuals, Computer programs, Compilers, Data processing systems, Stochastic processes, Monte Carlo method.
Identifiers: SARSIM(Search and Rescue Simulation Model), Search and rescue simulation model, Resource allocation, Computerized simulation, FORTRAN, FORTRAN 5 programming language.

The volume is one of a series which documents a Search and Rescue Simulation Model for the United States Coast Guard. The report discusses the programmer level documentation for 'PREPROCESSOR'.

AD-735 414/CP PC **A07** MF **A01**
National Bureau of Standards Washington D C
A Search and Rescue Simulation Model for the United Coast Guard. Volume IV. Programmer Level Documentation for 'OPSIM'
P. L. B. Saunders, and E. C. Leyendecker. Jun 71, 139p Rept no. NBS-10433
Errata sheet inserted. See also Volume 3, AD-735 413, and Volume 5, AD-735 415.

Descriptors: *Coast Guard, Operational readiness, *Sea rescues, Mathematical models, *Programming(Computers), Instruction manuals, Computer programs, Compilers, Data processing systems, Computer storage devices, Queueing theory, Search theory, Simulation.
Identifiers: SARSIM(Search and Rescue Simulation Model), Search and rescue simulation model, OPSIM computer program, Resource allocation.

The volume is one of a series which documents a Search and Rescue Simulation Model for the United States Coast Guard. The report discusses programmer level documentation for 'OPSIM'. (Author)

AD-735 415/CP PC **A04** MF **A01**
National Bureau of Standards Washington D C
A Search and Rescue Simulation Model for the United States Coast Guard. Volume V. Programmer Level Documentation for 'Post-processor'
W. Elliott, and S. S. Karp. Jun 71, 57p Rept no. NBS-10434
Errata sheet inserted. See also Volume 4, AD-735 414 and Appendix A, AD-735 416.

Descriptors: *Coast Guard, Operational readiness, *Sea rescues, Mathematical models, *Programming(Computers), Instruction manuals, Computer programs, Data processing systems, Control sequences, Statistical analysis.
Identifiers: SARSIM(Search and Rescue Simulation Model), Search and rescue simulation model, OPSIM computer program.

In order to examine the voluminous amount of data generated by a complex simulation such as SARSIM, an efficient post-processor is a definite requirement. The reader is reminded that the Standard Output display (from OPSIM) is given for each run of OPSIM. The OPSIM Section explains this output and the calculations. The processing of data other than that presented in the Standard Output is an option to the SARSIM user. To explain further, it is recalled that the Standard Output consists mostly of summary statistics on resource and station utilizations derived and output in several ways. (Author)

AD-735 416/CP PC **A06** MF **A01**
National Bureau of Standards Washington D C
A Search and Rescue Simulation Model for the United States Coast Guard. Appendix A. Flow Charts for Programmer Level Documentation
1971, 114p Rept no. NBS-10435
See also Volume 5, AD-735 415 and Appendix B, AD-735 417.

Descriptors: *Coast Guard, Operational readiness, *Sea rescues, Mathematical models, *Programming(Computers), Instruction manuals, Flow charting, Instruction manuals, Control sequences.
Identifiers: SARSIM(Search and Rescue Simulation Model), Search and rescue simulation model.

The volume is one of a series which documents a Search and Rescue Simulation Model for the United States Coast Guard. The report discusses the flow charts for programmer level documentation. (Author)

AD-735 417/CP PC **A08** MF **A01**
National Bureau of Standards Washington D C
A Search and Rescue Simulation Model for the United States Coast Guard. Appendix B. Program Listings for Programmer Level Documentation
1971, 173p Rept no. NBS-10436
See also Appendix A, AD-735 416.

Descriptors: *Coast Guard, Operational readiness, *Sea rescues, Mathematical models, *Computer programs, Instruction manuals, Instruction manuals, Data processing systems.
Identifiers: SARSIM(Search and Rescue Simulation Model), Search and rescue simulation model.

The volume is one of a series which documents a Search and Rescue Simulation Model for the United States Coast Guard. The report gives program listings for programmer level documentation. (Author)

AD-735 478/CP PC **A06** MF **A01**
Carnegie-Mellon Univ Pittsburgh Pa Dept of Computer Science
On the Matrix Polynomial, Lambda-Matrix and Block Eigenvalue Problems
Scientific rept.
J. E. Dennis, Jr, J. F. Traub, and R. P. Weber. 17 Dec 71, 123p Rept no. CMU-CS-71-110
Contract N00014-67-A-0314-0010, F44620-70-C-0107
Prepared in cooperation with Cornell Univ., Ithaca, N.Y. Grant NSF-GJ-27528 and Bell Telephone Labs., Whippany, N.J.

Descriptors: *Matrix algebra, Algorithms, Polynomials, Interpolation, Vector spaces, Convergence, Numerical analysis, Computer programs.
Identifiers: Eigenvalues, Existence theorems.

A matrix S is a solvent of the matrix polynomial M(X) identically equal to X sup m + A(sub 1) X sup(M - 1) + ... + A sub m, if M(S) = 0, where A sub i, X and S are square matrices. The authors present some new mathematical results for matrix polynomials, as well as a globally convergent algorithm for calculating such solvents. In the theoretical part of this paper, existence theorems for solvents, a generalized division, interpolation, a block Vandermonde, and a generalized Lagrangian basis are studied. Algorithms are presented which generalize Traub's scalar polynomial methods, Bernoulli's method, and eigenvector powering. The related lambda-matrix problem, that of finding a scalar lambda such that l(lambda sup m) + A(sub 1)lambda sup(M - 1) + ... + A sup m is singular, is examined along with the matrix polynomial problem. The matrix polynomial problem can be cast into a block eigenvalue formulation as follows. Given a matrix A of order mn, find a matrix X of order n, such that AV = VX, where V is a matrix of full rank. Some of the implications of this new block eigenvalue formulation are considered. (Author)

AD-735 599/CP PC **A05** MF **A01**
Rand Corp Santa Monica Calif
Questionnaire--Models, Computer Machine Simulations, Games and Studies
Martin Shubik, and Garry Brewer. Jul 71, 78p Rept no. P-4672

Descriptors: *Mathematical models, *Questionnaires, *Game theory, *Programming(Computers), Man-machine systems, War games, Economics, Management engineering, Decision making, Costs, Standards, Control systems, Simulation.
Identifiers: Computerized simulation.

The purpose of the report is to aid the interested professional in describing, characterizing, and analyzing his game, model, or simulation. It is a first and, hopefully, useful step in the clarification of professional standards in the work on gaming and simulation. Furthermore, the report is designed so that it might also serve as a device for communicating and cataloging different games and simulations in a format that encourages easy interchange of information. (Author)

AD-736 534/CP PC **A05** MF **A01**
Naval Postgraduate School Monterey Calif
An Information Theory Approach to a Fault Location Problem
Master's thesis
David Russell Campbell. Sep 71, 82p

Descriptors: *Failure(Electronics), Position finding, *Failure(Mechanics), Position finding, Information theory, Dynamic programming, Statistical analysis, Reliability, Computer programs, Theses.
Identifiers: FORTRAN 4 programming language, FORTRAN, *Fault detection.

The fault location model under investigation consists of an n-component series system known to have exactly one failed component. Component positions in the system are taken as fixed. A component is either working or failed. Components work or fail independently of each other, with their a priori reliabilities taken as given but not necessarily equal. Group testing to locate the failed component is sequential, binary and dichotomous in nature with certain results. The only costs are the number of tests made. The three solution procedures investigated are (1) a dynamic programming formulation, (2) a sequential halving procedure, and (3) a procedure based on information theory. The criteria for optimality are minimization of the expected number of tests required and minimization of the maximum number of tests required. (Author)

AD-737 008/CP Reprint
California Univ Los Angeles School of Engineering and Applied Science
Patterns and Search Statistics
Allen Klinger. 1971, 36p AFOSR-TR-72-0359
Grant AF-AFOSR-1915-70, NSF-GK-4827
Availability: Pub. in Optimizing Methods in Statistics, 1971, p303-337.

Descriptors: *Pattern recognition, Statistical analysis, Decision theory, Game theory, Mathematical models, Statistical tests, Information retrieval, Sequential analysis, Artificial intelligence, Search theory, Optical images.

The nature of this paper is expository and the goal is to outline many problems which exist in the planning and execution of a search of a small two-dimensional visual field or pattern. No theorems are stated and whatever tables and figures are presented constitute trial cases needed to illustrate a conceptual approach. This material thus constitutes a working record of an exploration into a rich problem area. It is hoped that the record will stimulate intensive efforts in this fundamental area of pattern perception by automatic means. (Author)

AD-737 186/CP PC **A04** MF **A01**
Naval Research Lab Washington D C
LPSUB - A Fortran Subroutine for Solving Any Standard Linear Programming Problem of a Size Compatible with the Computer Being Used
Final rept.
Charlotte M. Davisson. Jan 72, 69p Rept nos. NRL-MR-2383, NRL-Computer Bull-27

Descriptors: *Linear programming, *Subroutines, Computer programs, Simplex method, Numerical analysis.
Identifiers: FORTRAN 4 programming language, FORTRAN, LPTEST computer program.

LPSUB is a subroutine for solving standard linear programming problems. It uses the revised simplex method, and thus yields the answers to both the primal and dual problems. Slack and artificial variables are set up within the subroutine. By changing the dimensioning values in the dimension statement and the value of the largest real number the computer can handle, the subroutine can be used on any sized computer using FORTRAN IV to solve a problem with any number of constraints or variables compatible with computer size. The subroutine contains complete printouts of the initial tableau and the tableau of each iteration, but these can easily be removed for routine use, and the running time greatly reduced. (Author)

AD-737 347/CP PC **A05** MF **A01**
Stanford Univ Calif Stanford Electronics Labs
A Modular Organization of a Digital Integrating Computer for the Numerical Solution of Differential Equations
Technical rept.
E. J. Schulz. Dec 71, 92p Rept nos. SU-SEL-71-057, TR-3606-6
Contract N00014-67-A-0112-0044

Descriptors: *Programming(Computers), Differential equations, *Differential equations, Numerical analysis, Digital differential analyzers, Interfaces, Integrators, Partial differential equations, Nonlinear differential equations, Integration, Iterations.
Identifiers: Computerized simulation, Computer aided analysis.

The automatic solution of differential equations may be accomplished by either modeling the equation on an analog computer or by solving it numerically on a general-purpose computer. Both methods are cumbersome and have the disadvantages of low accuracy and slow speed, respectively. The development of the digital differential analyzer promised a machine with improved accuracy and speed. The difficulty in programming and the reliance on complex switching networks or patch boards brought about by ever-increasing parallelism, however, have prevented the full exploitation of the DDA capabilities. A modular machine structure employing serial-parallel processing and using incremental integration as its basic algorithm has been developed. The system consists of self-contained modules which may be operated independently or may be operated indeoendently or may be combined to solve numerically one or more differential equations. Modularity and serial-parallel processing simplify the communication methods within and between modules to permit automatic programming; the hardware requirements are reduced as in seriel processing, but the iteration time cannot exceed a fixed maximum regardless of the problem. (Author)

AD-737 744/CP PC **A14**/MF **A01**
Michigan Univ Ann Arbor Systems Research Lab
A Characterization of the Visibility Process and Its Effect on Search Policies
Technical rept.
Michael Leo Moore. Dec 71, 321p Rept no. SRL-2147-TR-71-3
Contract N00014-67-A-0181-0012

Descriptors: *Armed Forces operations, *Combat surveillance, *Search theory, Target recognition, Military intelligence, Visibility, Game theory, Dynamic programming, Stochastic processes, Probability density functions, Statistical analysis, Computer programs, Algorithms, Mathematical models.
Identifiers: Allocation models.

The work described in the report considers an important environmental effect -- the visibility process. The research explores the development of mathematical structures which link the detection and visibility processes, examines the effect that the visibility process has on classical search strategies, and provides guidelines regarding search situations which require explicit consideration of the visibility process in the development of optimal search policies. (Author)

AD-738 027/CP PC **A08**/MF **A01**
Stanford Univ Calif Dept of Computer Science
An Efficient Planarity Algorithm
Robert E. Tarjan. Nov 71, 158p Rept no. STAN-CS-244-71
Contract N00014-67-A-0112-0057

Descriptors: *Topology, Graphics, Geometry, Matrix algebra, Set theory, Mapping(Transformations), Computer programs, Combinatorial analysis, Artificial intelligence, Algorithms.
Identifiers: *Graph theory, Imbeddings(Mathematics).

An efficient algorithm is presented for determining whether a graph G can be embedded in the plane. Depth-first search, or backtracking, is the most important of the techniques used by the algorithm. If G has V vertices, the algorithm requires O(V) space and O(V) time when implemented on a tandom access computer. An implementation on the Stanford IBM 360/67 successfully analyzed graphs with as many as 900 vertices in less than 12 seconds. (Author)

AD-738 099/CP Not available NTIS
Rand Corp Santa Monica Calif
Introduction to Statistics and Data Analysis with Computer Application I
Carl Morris, and John Rolph. Sep 71, 173p Rept no. P-4695
See also report dated Sep 71, AD-738 100.
Availability: Paper copy available from the RAND Corp., Santa Monica, Calif. 95001, $3.00. No copies furnished by DDC or NTIS.

Descriptors: *Statistical analysis, *Programming(Computers), Statistical tests, Sampling, Statistical distributions, Probability, Data processing systems, Instruction manuals, Education.
Identifiers: JOSS computer systems, JOSS computer program, Goodness of fit tests, Histograms, Chi square test, Degrees of freedom, Lectures.

For convenience sake, the authors have put together here the material used in the Statistics and Data Analysis given at Rand during the second quarter of the Rand graduate program in policy analysis. This first ten week segment given during January, 1971 through March 1971 is being followed by a second ten week segment given during April 1971 through June 1971. The notes produced here are unrevised and frequently incomplete. Page number references in the notes refer to the within lecture numbering given at the top of the pages. The Table of Contents refers to the sequential numbering at the bottom of the pages. (Author)

AD-738 100/CP Not available NTIS
Rand Corp Santa Monica Calif
Introduction to Statistics and Data Analysis with Computer Applications II
Carl Morris, and John Rolph. Sep 71, 127p Rept no. P-4696
See also report dated Sep 71, AD-738 099.
Availability: Paper copy available from the RAND Corp., Santa Monica, Calif. 95001, $3.00. No copies furnished by DDC or NTIS.

Descriptors: *Statistical analysis, *Programming(Computers), Statistical tests, Statistical distributions, Probability, Regression analysis, Correlation techniques, Data processing systems, Instruction manuals, Education.
Identifiers: JOSS computer systems, JOSS computer program, Goodness of fit tests, Chi square test, Histograms, Lectures, Degrees of freedom.

For convenience sake, the authors have put together the material used in the second segment of our Statistics and Data Analysis course given in the Rand Graduate Institute in Policy Analysis during April 1971 through June 1971. The material given in the first segment (Lectures 1-9) is contained in: Introduction to Statistics and Data Analysis with Computer Applications I, P-4695, whose table of contents follows. The presentation does not assume that students know calculus. (Author)

AD-738 170/CP PC **A03**/MF **A01**
Michigan Univ Ann Arbor Dept of Mathematics
An Algorithm for Generalized Matrix Eigenvalue Problems
Technical rept.
C. B. Moler, and G. W. Stewart. Feb 72, 50p
Rept nos. TR-3, 027750-3-T
Contract N00014-67-A-0181-0023

Descriptors: *Matrix algebra, Algorithms, Transformations(Mathematics), Iterative methods, Theorems, Computer programs.
Identifiers: Eigenvalues.

A new method, called the QZ algorithm, is presented for the solution of the matrix eigenvalue problem Ax = lambda Bx with the general square matrices A and B. Particular attention is paid to the degeneracies which result when B is singular. No inversions of B or its submatrices are used. The algorithm is a generalization of the QR algorithm, and reduces to it when B=I. Problems involving powers of lambda are also mentioned. (Author)

AD-738 301/CP PC **A23**/MF **A01**
Office of the Assistant for Study Support Kirtland AFB N Mex
Cluster Analysis for Applications
Rept. for Jun 70-Dec 71
Michael R. Anderberg. Jan 72, 534p Rept no. OAS-TR-72-1
Doctoral thesis.

Descriptors: *Statistical analysis, Classification, Mathematical prediction, Sampling, Probability, Analysis of variance, Transformations(Mathematics), Computer programs, Regression analysis, Correlation techniques, Factor analysis, Information retrieval, Linguistics, Topology, Theses.
Identifiers: *Cluster analysis, Applications of mathematics, Order statistics, Graph theory, Clumps.

Cluster analysis is a collective term covering a wide variety of techniques designed to delineate natural groups or clusters in data sets. The published works pertinent to cluster analysis are rich with hundreds of valuable contributions but are scattered through the literature of more than thirty major fields of study. The report provides the necessary elements of data analysis, statistics, cluster analysis and computer implementation vertically integrated to cover the complete path from raw data to the finished analysis. Conceptual and philosophical problems of using cluster analysis as a tool of discovery are treated for the first time. A comprehensive discussion of variables, scales and measures of association is provided to establish a sound basis for constructing an operational definition of similarity tailored to the needs of the particular problem at hand; special attention is devoted to the problems of analyzing data sets containing mixtures of nominal ordinal and interval variables. (Author)

AD-738 468/CP PC **A06**/MF **A01**
Varian Associates Palo Alto Calif Vacuum Div
Exact Null Distributions and Asymptotic Expansions for Rank Test Statistics
Technical rept.
Warren F. Rogers. 26 Dec 71, 110p Rept nos. TR-145, TR-35
Contract N00014-67-A-0112-0052, Grant NSF-GP-30711X

Descriptors: *Statistical tests, Theorems, Statistical distributions, Asymptotic series, Regression analysis, Computer programs, Algorithms.
Identifiers: Kolmogorov-Smirnov test, Generating functions, Limit theorems, FORTRAN 4 programming language, FORTRAN, Ranking.

Efficient algorithms are developed for inverting the probability generating functions of the distributions of rank test statistics. A method is given for deriving probability generating functions in a form suitable for inversion. Cases treated include one and two sample linear rank statistics and the Kolmogorov-Smirnov test statistics. A proof is given that one term of the Edgeworth series provides a valid asymptotic expansion for the Wilcoxon two sample distribution. Explicit bounds are given for the error in approximating the distribution by the one term expansion. It is shown that the error in the uncorrected normal approximation is of the order max(1/n, 1/m). (Author)

AD-738 473/CP PC **A03**/MF **A01**
Stanford Univ Calif Dept of Statistics
The Use of Faces to Represent Points in n-Dimensional Space Graphically
Technical rept.
Herman Chernoff. 27 Dec 71, 48p Rept no. TR-71
Contract N00014-67-A-0112-0051

Descriptors: *Programming(Computers), Graphics, *Multivariate analysis, Pattern recognition, Sampling, Sequential analysis, Computer programs.
Identifiers: *Cluster analysis, *Computer graphics.

A new method of representing multivariate data graphically is described. Briefly, it consists of representing a point in k-dimensional space by a picture of a face whose characteristics are determined by the position of the point. A sample of points in k-dimensional space is represented by a collection of faces. Two illustrations are sketched briefly. Detailed documentation, including the data

for the illustrative examples and the method of generating the faces, is included. (Author)

AD-738 872/CP PC A06/MF A01
Naval Postgraduate School Monterey Calif
Simulation and Control of Distributed Parameter Systems
Master's thesis
Antonio Luis de Carvalho Moitinho de A. Dec 71, 112p

Descriptors: *Adaptive control systems, Mathematical models, Partial differential equations, Time-lag theory, Integral transforms, Monte Carlo method, Computer programs, Automation, Simulation, Feedback, Theses.
Identifiers: *Control theory, Automatic control, *Distributed parameter systems, Laplace transformation, Riccati equation.

The present work is an attempt to put together the most relevant aspects of the engineering problems involving distributed parameter systems. Simulation and optimal control are explained in detail. The original contribution of this themis is given in Chapters 5 and 6, where modal control theory and a gradient subroutine that searches for the optimal reference coefficients are used. As a result, it was possible to obtain an output distribution better than the one achievable by the known methods. This technique works in situations of strongly nonlinear control and compensates the effect of having the analyzer and synthesizer approximated by low order matrices. It also makes it possible to give higher weight to some zones of the output distribution in order to have a better local fit. (Author)

AD-738 919/CP PC A04/MF A01
Naval Postgraduate School Monterey Calif
Statistical Extrapolation
Master's thesis
Dennis Randolph Oldson. Sep 71, 67p

Descriptors: *Statistical analysis, Systems engineering, *Circuits, Performance(Engineering), Approximation(Mathematics), Measure theory, Integration, Numerical analysis, Monte Carlo method, Confidence limits, Probability density functions, Computer programs, Theses.
Identifiers: Extrapolation, Numerical integration, *Statistical extrapolation.

The mathematics of extrapolating known statistics of components to the probability density function of a system's performance measure is considered. Quadrature sum integration schemes for evaluating the resulting required integration are examined, and alternate integral approximation schemes are developed utilizing Monte Carlo methods. A simple electrical circuit example illustrates the use of these techniques. (Author)

AD-738 939/CP PC A04/MF A01
Texas A and M Univ College Station Dept of Industrial Engineering
Determination of Transient Availability under Dependent Failures or Infinite Replacement Times
Charles A. Pollard, Jr. May 69, 72p

Descriptors: *Replacement theory, Stochastic processes, Integral transforms, Differential equations, Matrix algebra, Maintenance, Mathematical models, Computer programs, Theses.
Identifiers: Markov processes, Laplace transformation, Availability.

The primary objective of the paper is to provide general availability functions for systems which involve repair. To solve the given problem, the Markovian process and Laplace Transforms are used to advantage. Two availability functions are derived, one general function and one restricted function. The general availability function is derived for a system which uses spares for repair of failed units. For this sytem it is assumed that replacement times can occur. The restricted availability function is derived for a system which uses spares with instantaneous replacement and complete repair of failed units. (Author)

AD-738 941/CP PC A04/MF A01
Texas A and M Univ College Station Dept of Industrial Engineering
Dynamic Programming Approach to Resource Scheduling under Constraints
David A. Tyburski. May 69, 64p

Descriptors: *Budgets, Scheduling, *Dynamic programming, Optimization, Management planning, Mathematical models, Computer programs, Theses.
Identifiers: *Resource allocation, Allocation models, Penalty functions, Constraints.

One of the most difficult problems encountered by the activity planner is the scheduling of activities under constraints. Too frequently, the best arrangement of activities may violate a constraint on the amount of resource available. A solution to this problem is presented in the paper, treating the resource allocation problem as a one dimensional allocation dynamic programming problem. If the cost of each activity, the penalty for not completing an activity, and the budget constraints for each budget period are known, it is possible to allocate resources optimally subject to the constraints given. Because of the nature of the dynamic programming, the optimal solution is determined for each value of resource available. The restrictive assumptions are explained in detail and provision for implementation has been provided by an automated algorithm that will allocate resources optimally to any number of budget periods under any given constraints on resources. (Author)

AD-738 946/CP PC A04/MF A01
Texas A and M Univ College Station Dept of Industrial Engineering
Exact and Approximating Solutions to the Success Runs Problem
Billy G. Murphy. Jan 68, 58p

Descriptors: *Reliability, Sequential analysis, Probability, Experimental design, Approximation(Mathematics), Curve fitting, Nomographs, Computer programs.
Identifiers: Risk.

A method for calculating the exact risk for the success runs problem is explained and nomographs from which the minimum test size may be determined, with an upper bound on the Type 1 error, are included in the paper. An approximate and an exact solution were used in development of the nomographs, both of which are explained. Some discussion is included concerning the appropriate method for problems not solvable by the nomographs. Algorithms for both the approximate and exact solutions were written. The latter was generalized to provide an automated solution to the success runs problem. (Author)

AD-738 956/CP PC A05/MF A01
Texas A and M Univ College Station Dept of Industrial Engineering
Life and Reliability Testing: A Method of Failure Distribution Sensitivity Analysis
Research rept.
Jerry L. Chapin. May 70, 82p
Master's thesis.

Descriptors: *Reliability, Statistical analysis, Sequential analysis, Statistical distributions, Probability, Acceptability, Mathematical models, Computer programs, Life expectancy, Mathematical prediction, Theses.
Identifiers: *Life tests, Weibull density functions, Normal density functions, Risk, Sensitivity analysis, Exponential density functions.

The fourfold purpose of the paper is to: Present a general discussion of the concepts involved in reliability and life testing; Discuss some of the currently available life and reliability testing procedures based on the exponential, Weibull, and normal distributions; Develop two methods for evaluating the error incurred when an incorrect underlying failure distribution is assumed; Present some general results obtained by applying the error evaluation techniques developed. (Author)

AD-738 961/CP PC A05/MF A01
Texas A and M Univ College Station Dept of Industrial Engineering
Operating Policy Optimization Using the Markov Process as a System Model
Walter A. III Storrs. May 69, 82p

Descriptors: *Management planning, Stochastic processes, *Reliability, Stochastic processes, Matrix algebra, Iterative methods, Costs, Computer programs, Mathematical models, Simulation.
Identifiers: *Markov processes, Computerized simulation, FORTRAN 4 programming language, FORTRAN.

The objective of the paper is to present the Markov Process as a system model and to demonstrate two techniques for the optimization of a system's Operating Policy. The two techniques are fully explained in Chapters 1 and 2 and provide methods of choosing an Optimum Operating Policy from a set of possible policies. Chapters 3 and 4 contain the solution to two types of problems: a direct application to determine and Optimum Operating Policy, and an extension of the analysis to determine final system specifications as in the case of a new system. The exampie problems demonstrate that in some cases, using the Markov Process as a system model is a more efficient method of analysis than a computerized simulation. (Author)

AD-739 016/CP PC A03/MF A01
Texas A and M Univ College Station Dept of Industrial Engineering
An Optimization Approach to the Determination of Maintenance Float Requirements
Robert Dale White. Dec 67, 50p

Descriptors: *Replacement theory, Spare parts, Army equipment, Maintenance, Mathematical models, Dynamic programming, Computer programs, Optimization, Theses.

There are various methods in use today to insure a certain system effectiveness at minimum cost. The method chosen for a specific system is the result of many Reliability-Maintainability studies, Cost-Effectiveness studies and various other trade-off studies. One of these methods, the concept of maintenance float is the subject of the paper. This paper points out some of the many decisions leading to the selection of maintenance float as a method of assuring a specific system availability. The procedure utilized by the Army to calculate the maintenance float requirements of an equipment system does not necessarily yield the optimum solution. The objective of the paper is to present an optimization approach to the solution of maintenance float requirements. The optimization problem lends itself readily to the technique of dynamic programming. A general explanation of dynamic programming is culminated with a computer program utilizing the dynamic programming technique to obtain a solution to the optimization problem. (Author)

AD-739 017/CP PC A04/MF A01
Texas A and M Univ College Station Dept of Industrial Engineering
Optimization of Overhaul Costs for Multi-Functional Systems with Degradation
Master's thesis
Marshall I. Jaffe. May 69, 66p

Descriptors: *Maintenance, Costs, *Dynamic programming, Algorithms, Stochastic processes, Mathematical models, Reliability, Computer programs, Optimization, Theses.
Identifiers: Markov processes, *Overhauling, FORTRAN 4 programming language, FORTRAN.

The paper contains an automated algorithm designed to determine the optimal overhead cost for systems designed to perform at sequentially degraded functional levels. Development of the algorithm is focused upon the theory of the Markovian process and principles of dynamic programming. (Author)

AD-739 584/CP PC A04/MF A01
Texas A and M Univ College Station Dept of Industrial Engineering

The Gamma Distribution in Downtime Analysis
Research rept.
Stephen Michael Rolwing. May 68, 55p
Master's thesis.

Descriptors: *Statistical distributions, Maintainability, Curve fitting, Moments, Computer programs, Theses.
Identifiers: *Gamma function, Downtime, Parameter estimation.

The paper discusses the application of the three and four parameter Gamma distributions to problems involving downtimes. A method for estimating parameter values from empirical data is given for the three parameter distribution. The procedure is illustrated by several examples and a computer program capable of performing the required calculations is included. In addition, the paper stresses the convenience of the Gamma distribution in downtime analysis. This distribution is especially useful in those cases in which convolutions are involved. (Author)

AD-739 913/CP PC **A02**/MF **A01**
Picatinny Arsenal Dover N J
A Fortran Program that Computes Fisher's Exact Method of Comparing Two Percentages
Technical rept.
Donald C. Rappaport. Mar 72, 13p Rept no. PA-TR-4330

Descriptors: *Statistical analysis, *Computer programs, Experimental design, Ordnance, Decision making.
Identifiers: FORTRAN.

A FORTRAN computer program was devised which computes Fisher's exact method of comparing two percentages. The probability derived from this program can be used in making ordnance design decisions. The capacity and efficiency have been increased over other known methods. (Author)

AD-740 119/CP PC **A07**/MF **A01**
California Univ Berkeley Operations Research Center
A Multi-Commodity Concave Cost Minimization Problem for Communication Networks
Research rept.
Sen Subhabrata. Feb 72, 132p Rept no. ORC-72-5
Contract DA-31-124-ARO(D)-331

Descriptors: *Telephone communication systems, Mathematical models, *Mathematical programming, Optimization, Networks, Synthesis, Convex sets, Curve fitting, Graphics, Costs, Algorithms, Computer programs, Theses.
Identifiers: Network analysis theory, *Network synthesis, Concave programming, Network flows, FORTRAN 4 programming language, FORTRAN.

In this network synthesis problem a matrix giving flow requirements between each pair of points is specified, and the cost of flow in each arc is a concave function of the amount of flow. A flow pattern which fulfills the requirements at minimum cost is sought. The problem is formulated as a concave programming problem with linear constraints. All the practical difficulties of formulation and theoretical difficulties of identifying the globally minimal solution while avoiding locally minimal solutions are discussed. (Author)

AD-740 320/CP PC **A06**/MF **A01**
Massachusetts Inst of Tech Cambridge Project Mac
Analysis of Production Schemata by Petri Nets
Master's thesis
Michel Henri Theodore Hack. Feb 72, 114p Rept no. MAC-TR-94
Contract N00014-70-A-0362-0001, ARPA Order-433

Descriptors: *Programming(Computers), Graphics, Mathematical models, Set theory, Mathematical logic, Syntax, Sequences, Theorems, Theses.
Identifiers: MAC project, Petri nets, Systems analysis, Computer graphics, Graph theory, Finite state machines, *Systems theory.

Petri nets provide a powerful graphical tool for representing and analyzing complex concurrent systems. Properties such as hang-up freeness, determinacy, conflict, concurrency and dependency, can be represented and studied. The precise relationship between structural and behavioral properties, and between local and global properties is not well understood for the most general class of Petri Nets. The thesis presents such results for a restricted class of Petri Nets called Free Choice Petri Nets, and for a corresponding class of Systems called Production Schemata. Results on structural constraints guaranteeing global operation, and decompositions of complex systems into meaningful parts, are also presented. (Author)

AD-741 393/CP PC **A03**/MF **A01**
Iowa Univ Iowa City Coll of Engineering
Dynamic Optimization of Vehicular Structures
Technical rept.
J. S. Arora, W. F. Ames, D. T. Davy, E. J. Finck, and G. M. Lance. Apr 72, 38p Rept no. THEMIS-UI-40
Contract DAAF03-69-C-0014
Report on Vibration and Stability of Military and Other Complex Vehicular Systems.

Descriptors: *Vehicles, Optimization, Design, Mathematical models, Nonlinear programming, Calculus of variations, Minimax technique, Vibration, Partial differential equations, Equations of motion, Computer programs.
Identifiers: Degrees of freedom, Two degrees of freedom, Themis project, Lagrange multipliers.

In the report, optimal design of vehicular structures with respect to their dynamic performance is considered. The problem of optimal design is stated precisely in mathematical terms. The iterative optimization procedure is based on the necessary conditions of the calculus of variations. A simple two degrees of freedom model is considered and a minimax principle is used which reduces the problem to that of finite dimensional nonlinear programming problem. The objective function for this problem consists of various absolute maximum values of velocities and accelerations. The results for various cases of this problem are presented. Finally, the listing of the computer program is given in an Appendix. (Author)

AD-741 449/CP PC **A06**/MF **A01**
Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering
FORSTRAN: A Case In Force Structure Analysis
Master's thesis
David Kent Stubbs. Mar 72, 122p Rept no. GSA/SM/72-14

Descriptors: *Management planning, *Decision making, Budgets, Decision theory, Computer programs, Theses.
Identifiers: Force structure, Planning programming budgeting, FORSTRAN(FORce STRucture ANalysis), Force structure analysis.

There has been considerable emphasis recently on analysis (systems, economic, cost-benefit, etc.) in government decisionmaking activities. One approach which is currently popular is the Planning-Programming-Budgeting System (PPBS). PPBS is often described as a means of helping responsible officials make decisions. The implication of the system is that it interrelates the planning, budgeting, and decisionmaking functions. Regardless of the name of the system presently in use, the relationships among these three management activities is of primary importance. This paper develops a methodology to aid the educational process of future decisionmakers in their efforts to integrate quantitative and non-quantitative aspects bearing on planning, budgeting, and decision problems. The final product is a case study in force structure analysis (FORSTRAN). (Author)

AD-741 900/CP Reprint
Case Western Reserve Univ Cleveland Ohio Systems Research Center
GPS and Decision Making: An Overview
George W. Ernst. 1970, 50p AFOSR-TR-72-1065
Grant AF-AFOSR-125-67, NSF-GK-1386
Availability: Pub. in Theoretical Approaches to Non-Numerical Probelm Solving, p59-107 1970.

Descriptors: *Programming(Computers), Problem solving, Artificial intelligence, Decision making, Mathematical logic.
Identifiers: GPS computer program, Cannibals and missionaries problem, Tower of Hanoi puzzle, Heuristic methods.

GPS (the General Problem Solver) is a computer program conceived in 1957 by A. Newell, J. C. Shaw and H. A. Simon. Since then, the program has existed in seven different running versions each of which was designed to face a slightly different set of difficulties arising in the construction of general problem solver--an ambitious objective to say the least. The paper is an overview of the research on GPS. The paper is organized around some of the decisions that GPS confronts during the course of solving a problem. (Author)

AD-742 018/CP PC **A10**/MF **A01**
Naval Postgraduate School Monterey Calif
A Compiler for the Interactive Solution of Differential Equations
Master's thesis
Harvey Gordon Nelson. Jun 71, 221p

Descriptors: *Programming(Computers), Graphics, *Nonlinear differential equations, Integration, Computer programs, Compilers, Control systems, Mathematical models, Numerical analysis, Operators(Mathematics), Simulation, Theses.
Identifiers: Digital simulation, Interactive computer graphics, Runge-Kutta method, Numerical integration, Control theory, Bang band control, Interpreters FORTRAN.

A digital simulation language for the interactive definition and solution of piece-wise continuous non-linear ordinary differential equations using the Runge-Kutta method has been designed and implemented. The combination of interactive graphics approach and a special differential equation describtion language make the analysis program very versatile and easy to use. For second order systems, a grid of phase trajectory segments over the user specified phase plane is used as a background for the solutions. (Author)

AD-742 098/CP PC **A05**/MF **A01**
Institute for Defense Analyses Arlington Va Science and Technology Div
Computer Program for Solving Mathematical Programs With Nonlinear Programs in the Constraints
Research paper
Jerome Bracken, and James T. McGill. Mar 72, 100p P-801, IDA/HQ-71-13240

Descriptors: *Nonlinear programming, *Computer programs, Convex sets, Inequalities, Subroutines.
Identifiers: Constraints, INSUMT computer program.

The paper documents a computer program to be used in solving nonlinear programming problems with nonlinear programming problems in the constraints. The problem, named INSUMT, is used with the standard program, named SUMT, which implements the sequential unconstrained minimization technique for nonlinear programming. SUMT calls INSUMT when it is necessary to solve a nonlinear program in a constraint. The INSUMT program, together with a fairly complete example of its use, is included in the documentation. Theory and applications of the models which can be solved using this program are treated in two companion papers. (Author)

AD-742 454/CP PC **A03**/MF **A01**
Wisconsin Univ Madison Dept of Computer Sciences
Necessary and Sufficient Criteria for A-stability of Linear Multi-Step Integration Formulae
Technical rept.
Colin W. Cryer. Mar 72, 39p Rept no. TR-147
Contract N00014-67-A-0128-0004

Descriptors: *Initial value problems, Integration, *Programming(Computers), Initial value problems,

Difference equations, Polynomials, Complex variables, Numerical analysis, Computer programs, Theorems.
Identifiers: Finite differency theory, Numerical integration, Ordinary differential equations, STABLE computer program, FORTRAN.

No abstract available.

AD-742 903/CP PC **A08**/MF **A01**
Wisconsin Univ Madison Mathematics Research Center
A UNIVAC 1108 Program for Obtaining Rigorous Error Estimates for Approximate Solutions of Systems of Equations
Technical summary rept.
Dennis Kuba, and L. B. Rall. Jan 72, 159p Rept no. MRC-TSR-1168
Contract DA-31-124-ARO(D)-462

Descriptors: *Programming(Computers), *Iterative methods, Computer programs, Approximation(Mathematics), Matrix algebra, Nonlinear systems.
Identifiers: FORTRAN, Computation.

A computer program for the UNIVAC 1108 is described which obtains rigorous interval error bounds for approximate solutions of finite systems of nonlinear equations. Since the coefficients of the original system may take on interval values, the error bounds obtained include the contributions of truncation error for Newton's method, round-off error, and possible errors in the coefficients of the given system of equations. (Author)

AD-742 918/CP PC **A05**/MF **A01**
Naval Postgraduate School Monterey Calif
An Evaluation of the Poisson Class of Two Dimensional Evasive Game Strategies by Computer Simulation
Master's thesis
Thomas John Clothier. Mar 72, 78p

Descriptors: *Game theory, *Military strategy, Mathematical models, Kill probabilities, Evasion, Aircraft carriers, Guided missiles(Surface-to-surface), Probability density functions, Computer programs, Theses.
Identifiers: Pursuit evasion games, Computerized simulation.

The paper evaluates five maneuvering strategies for an evader in a two dimensional continuous evasive game. An evader's movement, in two dimensions at constant speed, is simulated by choosing courses that are independent and distributed according to one of the five course change rules. The times between course changes are independent exponential random variables. An improvement over a previously established least upper bound on evader survivability is presented. The bulk of this paper is the presentation of evader survivability as a result of the maneuvering strategy he employs. (Author)

AD-742 920/CP PC **A06**/MF **A01**
Naval Postgraduate School Monterey Calif
A Look at Some Methods of Solving Partial Differential Equations and Eigenvalue Problems
Master's thesis
Edward Leon Bloxom. Mar 72, 103p

Descriptors: *Partial differential equations, Integration, Dynamic programming, Calculus of variations, Matrix algebra, Approximation(Mathematics), Computer programs, Numerical analysis, Theses.
Identifiers: Eigenvalues, Rayleigh-Ritz method, Galerkin method, Elliptic differentail equations.

Four techniques for the numerical solution of partial differential equations and eigenvalue problems were investigated. Typical problems considered were elliptic partial differentail equations of the form U sub xx + U sub yy = f(x,y), or U sub xx + U sub yy + lambda squared U = O, where appropriate boundary conditions are specified so that the problem is self-adjoint. The four methods are relaxation, Galerkin, Rayleigh-Ritz, and dynamic programming combined with Stodola'a method, for eigenvalue problems. The results indicated that for eigenvalue problems relaxation or dynamic programming modified is to be preferred usually and for partial differential equations Galerkin or dynamic programming is preferred. (Author)

AD-743 078/CP PC **A09**/MF **A01**
Naval Postgraduate School Monterey Calif
An Investigation of the Power of the Wald-Wolfowitz, Two Sample, Runs Test
Master's thesis
William C. Heschl. Mar 72, 191p

Descriptors: *Statistical tests, Sampling, Statistical distributions, Random variables, Stochastic processes, Probability density functions, COMPUTER PROGRAMS, Tables, Theses.
Identifiers: Nonparametric statistics, Wald-Wolfowitz test.

In the absence of information concerning underlying distributions of populations being sampled, it is difficult to apply parametric statistical tests without possibly violating assumptions under which these tests have been derived. As a result, parametric statistical tests may provide invalid information and results in erroneous conclusions related to samples under observation. This undesirable effect leads statisticians toward the use of non-parametric tests which are unconcerned with the specific form of the underlying distributions. By computer sampling, the paper investigates the power of the Wald-Wolfowitz runs test as it pertains to normal, uniform and triangular distributions. The power is found to be satisfactory when it is possible to obtain large samples for comparison. (Author)

AD-743 108/CP PC **A08**/MF **A01**
Georgia Univ Athens Dept of Statistics and Computer Science
An Interactive Multivariate Data Analysis Program
Technical rept.
Anne A. Ballengee, and Rolf E. Bargmann. Mar 72, 155p Rept nos. TR-80, THEMIS-UGA-18
Contract N00014-69-A-0423

Descriptors: *Programming(Computers), *Multivariate analysis, Computer programs, Statistical tests, Matrix algebra, Classification, Instruction manuals, Analysis of variance.
Identifiers: Themis project, FORTRAN, Computer graphics, FORTRAN 4 programming language, FORTRAN.

The report contains description and program documentation of a conversational unit for univariate and multivariate analysis of data in regular or irregular two-way classification designs. The main part of the report is Chapter 4 which, on the basis of detailed illustrations, describes the question-and-answer frames on a Graphics (IBM 2250) console. The user is assumed to be a 'layman' in the sense that he need not be familiar with statistical analysis in computer programming techniques. He receive instructions for description of his data from the graphically displayed questions. He has a choice to make several plots of his data (for cells, rows, or columns of the design, each response variable vs. another response variable). In the univariate analysis he obtains detailed reports on means, adjusted means, and the analysis of variance tables, for each response variable. (Author)

AD-743 613/CP PC **A04**/MF **A01**
Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering
A Fortran Program for an Exact Test of Independence in an M X N Contigency Table
Master's thesis
Marvin F. Schwartz, Jr. Mar 72, 58p Rept no. GSA/MA/72-6

Descriptors: *Statistical analysis, *Computer programs, Matrix algebra, Statistical tests, Probability density functions, Mathematical prediction, Random variables, Hypergeometric functions, Approximation(Mathematics), Theses.
Identifiers: FORTRAN, *Contingency tables, Chi square test.

General m x n contingency tables are discussed along with relationships common to all such tables. The background for various probability models is presented as well as the theory for a general conditional test. The general test is then applied specifically to the probability model selected followed by a numerical example. A brief history of past efforts in computing the exact test is provided. Finally, the major portions of the FORTRAN program are presented along with some illustrative examples. The final program is included as a useful entity. (Author)

AD-743 619/CP PC **A04**/MF **A01**
Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering
An Investigation of Numerical Methods for Obtaining Green's Functions
Master's thesis
Jack L. Tills. Jun 72, 68p Rept no. GNE/PH/72-10

Descriptors: *Green's function, Numerical analysis, Iterative methods, Monte Carlo method, Boundary value problems, Partial differential equations, Computer programs, Theses, Potential theory.
Identifiers: Dirichlet problem, Relaxtion method(Mathematics).

The study was devoted to obtaining an optimal numerical method for computing discrete Green's functions for the Laplacian operator. Two competitive numerical methods were employed: successive over-relaxation and a modified Monte Carlo method, the Exodus method. Green's functions were computed for square and cubic grids. Comparisons were made on the basis of accuracy and required computation time. Accuracy was determined by comparing numerical Green's functions with analytical solutions. Both methods, iterative and statistical, gave comparable accuracy results. Required computation times for the successive overrelaxation method were consistently less than the Exodus method. For all regions considered, both planar and volumetric, the successive overrelaxation method was found to be the optimal numerical method for determining Green's functions accurately and rapidly. (Author)

AD-743 633/CP PC **A04**/MF **A01**
Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering
A Monte Carlo Technique Using Component Failure Test Data to Approximate Reliability Confidence Limits of Systems with Components Characterized by the Weibull Distribution
Master's thesis
Robert Grantham Lannon. Mar 72, 63p Rept no. GAM/MA/72-2

Descriptors: *Reliability, Confidence limits, Monte Carlo method, Statistical distributions, Computer programs, Sampling, Digital computers, Theses.
Identifiers: Weibull density functions, Computerized simulation, Maximum likelihood estimation, FORTRAN.

The paper develops a Monte Carlo technique which, with a digital computer, determines confidence limits for system reliability of complex systems containing components characterized by the Weibull distribution. The component distribution shape and scale parameters are estimated by the method of maximum likelihood from component failure times while the location parameter is assumed known. The asymptotic distribution of these maximum likelihood estimators and a Monte Carlo simulation are used to determine confidence limits on system reliability. As an example, confidence limits are calculated for two systems of up to eight components in combinations of series and parallel configurations using 99, 499, 999, and 2999 simulations. Accuracy of the confidence limits is found to be satisfactory after being checked by a method using a double Monte Carlo technique. (Author)

AD-743 717/CP PC **A03**/MF **A01**
Naval Postgraduate School Monterey Calif
A Study of a Modified Binary Search for Use in Sensitivity Testing
Master's thesis
Robert Eric III Hall. Mar 72, 39p

Descriptors: *Statistical analysis, Sensitivity, Search theory, Monte Carlo method, Distribution functions, Computer programs, Iterations, Theses.
Identifiers: Computerized simulation, Maximum likelihood estimation, Sensitivity analysis.

A modified binary search routine was developed by Tysver to provide inputs (estimates of parameters of threshold stimulus distributions) to the Probit and Staircase techniques for sensitivity testing. A high speed digital computer was used to provide simulated sensitivity data in order to test the modified search (more specifically, study the parameter estimates generated by the search). The results show that the modified search does not give practical input information to the techniques mentioned above. However, further refinements of extensions to the basic search patterns should yield better estimates of the distribution parameters. (Author)

AD-743 749/CP PC **A06**/MF **A01**
Naval Postgraduate School Monterey Calif
A Probabilistic Event-Step Computer Simulation of a Repairable Item Inventory System
Master's thesis
David J. Quirk. Mar 72, 106p

Descriptors: *Inventory control, Mathematical models, Inventory analysis, Naval procurement, Costs, Decision making, Computer programs, Statistical analysis, Lead time, Simulation, Queueing theory, Maintenance, Theses.
Identifiers: Computerized simulation, M/G/infinity queue, Repairable equipment.

A probabilistic event-step computer simulation of a repairable item inventory system with exponential inner-arrival times between demands is constructed. The model allows for a wide variety of repair times and lead times to be considered. The major parameters are investigated for their sensitivity to system changes in order to help the user evaluate given or proposed inventory policies and parameters. A complete description of the model is presented and various measures of supply performance such as the expected number of unit years of backorders per unit period and the fill rate are provided. All flow charts and the GPSS/360 program listing are included. (Author)

AD-744 361/CP MF **A01**
Maryland Univ College Park Computer Science Center
Approximation Formulas for Vocabulary Size for the One-, Two-, and Three-Parameter Rank Distributions
Technical rept.
H. P. Edmundson, G. Fastel, I. Tung, and W. Underwood. Mar 72, 78p Rept no. TR-188
Contract N00014-69-A-0239-0004, Grant NGL-21-002-008
Available in microfiche only.

Descriptors: *Statistical distributions, Approximation(Mathematics), Integrals, Special functions(Mathematical), Curve fitting, Graphics, Computer programs, Vocabulary.
Identifiers: Ranking, Zeta function.

The paper describes the derivation of approximation formulas for computing the vocabulary size for the 1-, 2-, and 3-parameter rank distributions. Error formulas are derived for the approximation formula in the 2-parameter rank distribuion. The derivations of the 2- and 3-parameter rank distributions depend on the ordinary and the generalized Riemann zeta functions, respectively. Asymptotes for the family of 2-parameter rank distribution curves are determined. Tables are computed and graphs are drawn relating parameter values to the vocabulary size for all distributions. (Author)

AD-744 492/CP PC **A05**/MF **A01**
Auburn Univ Ala Digital Systems Lab
A Fast Algorithm for Complete Minimization of Boolean Functions
Technical rept.
S. G. Shiva, and H. Troy Nagle, Jr. Jun 72, 77p Rept no. AU-T-24
Contract DAAH01-68-C-0296

Descriptors: *Special functions(Mathematical), Optimization, Mathematical logic, Algebras, Set theory, Logic circuits, Computer programs, Theorems, Algorithms.
Identifiers: *Boolean functions, Prime implicants, FORTRAN, Logic design.

Properties of the cellular n-cube representation are used to advantage in developing a fast algorithm for finding the Prime Implicants, Essential Prime Implicants and Non-essential Prime Implicants of a Boolean function. The algorithm is discussed and several examples are included showing computer solutions to selected Boolean function minimization problems. The complete FORTRAN source program listing for the automated algorithm is included. (Author)

AD-744 528/CP PC **A08**/MF **A01**
Florida Univ Gainesville Dept of Industrial and Systems Engineering
Stationary Analysis and Optimality Conditions for (o, S) Policies in Multi-Commodity Inventory Control Problems
Technical rept.
Nabil S. Faour, and Boghos . Sivazlian. Mar 72, 153p TR-62, AROD-T-1:89-RT
Contract DAHC04-68-C-0002

Descriptors: *Inventory control, Mathematical models, Decision theory, Mathematical programming, Management planning, Economics, Partial differential equations, Integral equations, Probability density functions, Integration, Numerical analysis, Computer programs, Theorems.
Identifiers: Themis project, Multicommodity network flows, Demand(Economics).

An m-commodity (m >or= 1) inventory control model with periodic review is formulated and studied when a dyadic stationary ordering (Sigma, S) policy in (E sup m) is used. It is assumed that: (1) the ordering decision at the beginning of each of a sequence of periods of time is affected by a single set up cost, a linear variable ordering cost and holding and shortage costs; (2) the demands for the items in each period are identically and independently distributed continuous random variables; (3) the delivery of orders is immediate; and (4) complete backlogging of unfilled demands is allowed. Next the model is analyzed by minimizing the expression for the stationary total expected cost per period. The set of simultaneous equations used to determine the optimal policy parameters are restated in terms of a real valued function in (E sup m). Finally, the optimization analysis is restricted to the special case of a two-commodity inventory control problem where the demands for the items obey the exponential distribution, and the holding and shortage costs are linear. (Author)

AD-744 592/CP PC **A07**/MF **A01**
Computer Applications Inc New York
A Manual for Calculating Confidence Limits on Equipment Availability. Volume III
Feb 70, 132p CAI-NY-6072-3, NAVSHIPS-9067-483-5030
Contract N00024-69-C-1219
See also AD-744 246.

Descriptors: *Reliability, Mathematical prediction, *Naval equipment, Abundance, Confidence limits, Statistical tests, Curve fitting, Graphics, Tables, Computer programs, Sampling.
Identifiers: Degrees of freedom, Exponential density functions, Lognormal density functions, Availability, Mean time between failures, Mean time to repair.

The availability of an equipment is defined as the probability that the equipment is operating satisfactorily at any point in time. The document describes manual procedures for calculating at any confidence level, confidence limits on the availability of an equipment from test data. Two cases are considered: When both times-to-failure and times-to-repair follow the exponential distribution; and, When the times-to-failure follow the exponential distribution and the times-to-repair follow the log-normal distribution with a known shape parameter. (Author)

AD-744 693/CP PC **A06**/MF **A01**
Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering
Conditional Best Linear Invariant Estimation of the Location and Scale Parameters of the Cauchy Distribution by the Use of Order Statistics
Master's thesis
Ralph M. Spory, Jr. Mar 72, 106p Rept no. GAM/MA/72-3

Descriptors: *Statistical distributions, Mathematical prediction, Probability density functions, Random variables, Sampling, Matrix algebra, Computer programs, Tables, Theses.
Identifiers: Order statistics, *Cauchy density functions, Parameter estimation, FORTRAN, Normal density functions.

Linear coefficients which can be applied to sample data from a Cauchy distribution to obtain estimates of the location and scale parameters are developed and tabled. Several previous works have presented such tables for nearly best linear unbiased estimation and best linear unbiased estimation of the parameters. The estimates developed in the paper are best in the sense that they possess minimum mean square error. By using exact values of the means, variances, and covariances of the Cauchy standardized order statistics and minimizing the mean square error functions, matrix equations are developed and solved to obtain the required coefficients. (Author)

AD-744 695/CP PC **A06**/MF **A01**
Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering
Robust Estimation Techniques for Location Parameter Estimation of Symmetric Distributions
Master's thesis
John Caso. Mar 72, 107p Rept no. GSA/MA/72-3

Descriptors: *Statistical analysis, Decision theory, Statistical distributions, Statistical tests, Probability, Monte Carlo method, Computer programs, Theses.
Identifiers: Robust procedures, Parameter estimation, Order statistics, Statistical inference, Probability distribution functions.

Several robust estimators are considered for analysis and explanation. Monte Carlo techniques are used to investigate the efficiency of these robust estimators relative to the best estimator for the distribution under consideration. Sample sizes of 12 and 24 were drawn 4200 times from five symmetric probability distributions. The results show that over a class of distributions the robust estimators provide a higher guaranteed efficiency than the best estimator for any particular distribution in the family. Some interesting results are apparent from an analysis of the graphs in Appendix C indicating some upper bounds on the size of the Monte Carlo sample when conducting this type of study. (Author)

AD-744 802/CP PC **A07**/MF **A01**
Army Weapons Command Rock Island Ill Systems Analysis Div
The Numerical Solution of Transient Queueing Problems
Final rept.
Stuart W. Olson. May 72, 127p Rept no. PAA-TR1-72
Master's thesis.

Descriptors: *Queueing theory, Mathematical models, Matrix algebra, Partial differential equations, Bessel functions, Power series, Computer programs, Mathematical logic, Numerical analysis, Difference equations, Integration, Theses.
Identifiers: Runge-Kutta method, M/M/1 queue, FORTRAN, FORTRAN 4 programming language.

The report explores methods for obtaining transient solutions to queueing problems which can be represented in the form of differential-difference equations. Six distinct methods, representing the most frequently-encountere in the open literature, are discussed as to their value in numerical work. The method of Runge-Kutta integration of these

equations was found to be superior to the numerical evaluation of analytic solutions of a particular queueing model. A generalized, Runge-Kutta programming package, written in FORTRAN IV for the IBM 360/65, is presented and described in detail for use on queueing problems. Generality is achieved by requiring the user to write a subroutine to evaluate his queueing equations when required by the programming package. (Author)

AD-745 022/CP PC **A04**/MF **A01**
Stanford Univ Calif Dept of Computer Science
A Generalization of the LR Algorithm to Solve AX = lambda BX
Technical rept.
Linda Kaufman. Apr 72, 73p Rept no. STAN-CS-72-276
Contract N00014-67-A-0112-0029

Descriptors: *Matrix algebra, Algorithms, Transformations(Mathematics), Polynomials, Permutations, Theorems, Computer programs.
Identifiers: Eigenvalues, Linear algebraic equations, FORTRAN.

In the paper, the author presents and analyzes an algorithm for finding x and lambda such that Ax = lambda Bx, where A and B are n x n matrices. The algorithm does not require matrix inversion, and may be used when either or both matrices are singular. The method is a generalization of Rutishauser's LR method for the standard eigenvalue problem Ax = lambda x and closely resembles the QZ algorithm given by Moler and Steward for the generalized problem given above. Unlike the QZ algorithm, which uses orthogonal transformations, the method, the LZ algorithm, uses elementary transformations. When either A or B is complex, the method should be more efficient. (Author)

AD-745 143/CP PC **A04**/MF **A01**
Naval Postgraduate School Monterey Calif
Interdiction of a Transportation Network
Master's thesis
Charles Putnam Preston, Jr. Mar 72, 57p

Descriptors: *Armed Forces transportation, Tactical bombing, *Armed Forces supplies, Vulnerability, Algorithms, Dynamic programming, Topology, Networks, Kill probabilities, Mathematical models, Decision theory, Computer programs, Theses.
Identifiers: Allocation models, Transportation models, Sorties, Network flows.

The problem of determining the optimum allocation of aircraft to an airstrike against a transportation network is investigated. The damage function is assumed to be exponential. A solution procedure is developed using dynamic programming and integer solutions are found. The number of aircraft to be assigned to the airstrike is considered a decision variable. A sensitivity analysis is run to determine the optimum value for this variable. (Author)

AD-745 430/CP PC **A04**/MF **A01**
Aerospace Research Labs Wright-Patterson AFB Ohio
The ARL Linear Algebra Library
Paul J. Nikolai. Aug 71, 71p Rept no. ARL-71-0137

Descriptors: *Computer programs, *Matrix algebra, Vector spaces, Mathematical models, Subroutines, Libraries, Algorithms.
Identifiers: Linear algebra, FORTRAN, Eigenvalues, Eigenvectors.

The purpose of the report is to present a comprehensive description of a library of numerical linear algebra programs written in the FORTRAN language. Sufficient mathematical background is provided to enable the knowledgeable non-specialist to use the programs to solve a variety of problems in science or engineering which depend on the rapid, accurate solution of linear systems or the determination of eigenvalues and eigenvectors of real symmetric matrices. In order to acquire a listing, card deck, or magnetic tape copy of the library, write directly to the author. (Author)

AD-745 641/CP PC **A06**/MF **A01**
Federal Aviation Administration Washington D C Office of Aviation Policy and Plans
An Application of Dynamic Programming to Capital Investment Decision Analysis
Final rept.
George J. Couluris. Sep 71, 110p Rept no. FAA-AV-71-5

Descriptors: *Dynamic programming, *Decision theory, *Air traffic control systems, Instrument landings, Money, Costs, Mathematical models, Computer programs, Probability, Management planning.
Identifiers: *Investments, *Benefit cost analysis, Sensitivity analysis, *Instrument landing systems.

The report describes a method of evaluating capital investment decisions that use the dynamic programming concept. Dynamic programming is an operations research technique that is effective in solving multistage decision problems. The dynamic programming process reduces many elaborate problems into a form that may be readily solved (provided the original problem is not excessively complicated). The particular problems discussed in the report concern the identification of an optimum capital investment decision. Typically, the problem involves the selection of a capital investment decision from a group of competing or alternative investment decisions. The method proposed in the report determines the discounted (present worth) value of the costs associated with each capital investment decision. (Author)

AD-745 756/CP PC **A07**/MF **A01**
Computer Applications Inc New York
System Failure Analyses Study. Volume I. Study Analyses, and Computer System Manual
Jun 68, 131p NAVSHIPS-0967-483-9010-Vol-1
Contract Nobsr-95210

Descriptors: *Reliability, Mathematical prediction, Confidence limits, Life expectancy, Probability density functions, Monte Carlo method, Computer programs, Malfunctions, Exponential functions, Random variables, Theorems.
Identifiers: Weibull density functions, Non repairable equipment.

The System Failure Analyses Study presents the summarized results of the program carried to develop procedures for determining confidence bounds on mean life and reliability for nonrepairable and repairable systems based on subsystem (i.e., component, subassembly, etc.) failure and repair data. (Author)

AD-746 117/CP PC **A06**/MF **A01**
Computer Applications Inc New York
A User's Manual for a General Purpose Program for Testing Distributional Assumptions, Volume II
Feb 70, 117p CAI-NY-6072-2, NAVSHIPS-0967-483-5020
Contract N00024-69-C-1219
See also Volume I, AD-746 116.

Descriptors: *Computer programs, *Statistical tests, *Reliability, Mathematical prediction, Instruction manuals, Sampling, Statistical distributions, Mathematical models.
Identifiers: FORTRAN, FORTRAN H programming language, Mean time between failures, Exponential density functions, Normal density functions, Lognormal density functions, Weibull density functions.

The user's manual provides a set of instructions for the use of a general purpose OS/360 FORTRAN H program for testing distributional assumptions. A description of computational procedures for each statistical test is also included as well as a listing of the computer program. The program, which uses the Shapiro-Wilk W-Test for distributional assumptions, is applicable to complete samples of size N, 3 > or = N > or = 50. (Author)

AD-746 161/CP PC **A06**/MF **A01**
Princeton Univ N J Dept of Statistics
On the Numerical Differentiation of Data
Technical rept.
R. S. Anderssen, and P. Bloomfield. Apr 72, 114p Rept no. TR-13-Ser-2
Contract N00014-67-A-0151-0017

Descriptors: *Numerical analysis, Statistical data, Analytic functions, Differential equations, Integral equations, Regression analysis, Time series analysis, Polynomials, Interpolation, Taylor's series, Approximation(Mathematics), Least squares method, Computer programs.
Identifiers: *Numerical differentiation, Spectrum analysis.

The differentiation of data numerically divides naturally into two distinct problems: (i) the differentiation of exact data, and (ii) the differentiation of non-exact (experimental) data. In the report, the authors examine both problems.

AD-746 286/CP PC **A03**/MF **A01**
Texas A and M Univ College Station
Maximum Likelihood Algorithms for Linear Models with Unequal Variances
Technical rept.
W. J. Hemmerle. 1972, 31p TR-11, AROD-8049:10-M
Contract DAHC04-69-C-0058
Report on New Develcpments in Sample Survey Theory.

Descriptors: *Analysis of variance, Mathematical prediction, Algorithms, Saddle point method, Partial differential equations, Numerical analysis, Computer programs, Mathematical models.
Identifiers: Maximum likelihood estimation, Newton-Raphson method, FORTRAN.

No abstract available.

AD-746 454/CP PC **A05**/MF **A01**
California Univ Berkeley Dept of Computer Sciences
A Program to Calculate Solutions and Error Bounds to Finite Interval Sturm-Liouville Eigenvalue Problems
Technical rept.
B. Gross, O. G. Johnson, and B. Parlett. Dec 71, 76p Rept no. TR-2
Contract N00014-69-A-0200-1017

Descriptors: *Programming(Computers), Errors, Matrix algebra, Differential equations, Approximation(Mathematics), Vector spaces, Computer programs, Functions.
Identifiers: Eigenvalues, *Sturm-Liouville theory, Error analysis.

No abstract available.

AD-746 455/CP PC **A04**/MF **A01**
California Univ Berkeley Dept of Computer Sciences
A Survey of Error Analysis
Technical rept.
W. Kahan. 27 Aug 71, 67p Rept no. TR-4
Contract N00014-69-A-0200-1017
Presented at the IFIP Congress 71 held at Ljubljana (Yugoslavia) on 27 Aug 71.

Descriptors: *Numerical analysis, Programming(Computers), *Programming(Computers), Errors, Numerical analysis, Algebra, Equations, Computer programs, Compilers.
Identifiers: *Error analysis, *Round off errors, FORTRAN, Arithmetic.

Rounding error is just one kind of error, and an easier kind to analyze than some others. Error and uncertainty in data is a more important kind, and not so easy to estimate nor analyze; here is where error analysts are currently busiest. The most refractory kind of error is attributable to flaws in the design of computer systems, both hardware and software, caused primarily by misconceptions about the other kinds of error. (Author)

AD-746 896/CP PC **A04**/MF **A01**
Michigan Univ Ann Arbor Dept of Physics

An Algorithm for the Generalized Matrix Eigenvalue Problem Ax = Lambda Bx
C. B. Moler, and G. W. Stewart. Oct 71, 52p
Contract N00014-67-A-0181-0023
Prepared in cooperation with Texas Univ., Austin. Center for Numerical Analysis, Grant NSF-GP-23655, Rept. no. CNA-32, and Stanford Univ., Calif. Dept of Computer Science, Rept. no. STAN-CS-232-71.

Descriptors: *Matrix algebra, Numerical analysis, Algorithms, Transformations(Mathematics), Perturbation theory, Computer programs, Theorems.
Identifiers: *QZ algorithms, Eigenvalues, QR algorithm, FORTRAN.

A new method, called the QZ algorithm, is presented for the solution of the matrix eigenvalue problem Ax = lambda Bx with general square matrices A and B. Particular attention is paid to the degeneracies which result when B is singular. No inversions of B or its submatrices are used. The algorithm is a generalization of the QR algorithm, and reduces to it when B = I. A FORTRAN program and some illustrative examples are included. (Author)

AD-747 262/CP PC **A03**/MF **A01**
Texas A and M Univ College Station
Computer Optimization for the Mixed Analysis of Variance Model Using Maximum Likelihood
Technical rept.
W. J. Hemmerle, and H. O. Hartley. Jul 72, 37p
Rept no. Tr-39
Contract N00014-68-A-0140

Descriptors: *Analysis of variance, Matrix algebra, Transformations(Mathematics), Partial differential equations, Distribution functions, Computer programs, Iterative methods, Optimization.
Identifiers: Newton-Raphson method, Maximum likelihood estimation, Themis project.

The W transformation, a matrix transformation, is developed and applied for the mixed analysis of variance model to compute maximum likelihood estimates of the variance components and fixed parameters. This transformation not only eliminates the need for the explicit computation of the n x n inverse matrix 1/H but permits handling the iterative calculations such that they do not depend upon n (the number of observations) in any way. Although not wedded to a particular numerical method, the W transformation is implemented in conjunction with a modified Newton-Raphson method in which variance components are restricted to being non-negative. (Author)

AD-747 503/CP PC **A10**/MF **A01**
Naval Postgraduate School Monterey Calif
Comparison of Predictor-Corrector Methods
Master's thesis
Romeo Liwanag Malig. Jun 72, 204p

Descriptors: *Differential equations, Integration, Difference equations, Numerical methods and procedures, Stability, Approximation(Mathematics), Errors, Computer programs, Theses.
Identifiers: FORTRAN, Applications of mathematics, Linear differential equations, *Predictor corrector methods, Ordinary differential equations.

The aim of the paper is to provide convenient predictor-corrector (P-C) methods for obtaining accurate numerical solution at a minimum cost to first order ordinary differential equations (ODE). In pursuing this goal, a unified development of the most popular and efficient P-C methods is presented, which includes derivation of formulas and analysis of error propagation and numerical stability. Each method is then coded and programmed using the FORTRAN language. Comparative analysis of the different P-C methods include both theoretical and numerical results. The numerical results were obtained by subjecting each method to a wide variety of test ODE, using a maximum of two corrector applications and a uniform series of step size values. By systematic comparison of the performance of each P-C method the most convenient P-C sets in terms of accuracy and minimum cost are established. (Author)

AD-748 172/CP PC **A02**/MF **A01**
Army Engineer Waterways Experiment Station Vicksburg Miss
A GE-225 Computer Program for Simple Linear and Curvilinear Regression Analyses (Method of Least Squares)
Jul 64, 21p Rept no. AEWES-Misc-Paper-5-667

Descriptors: *Regression analysis, Least squares method, *Curve fitting, *Programming(Computers), Correlation techniques, Confidence limits.

The GE-225 computer program described herein offers the research scientist and engineer a rapid method of computing coefficients of simple equations that best fit a set of experimental data points when a linear or curvilinear correlation is indicated between the two variables x and y. This linearity can be predetermined from a straight-line plot of these data on either rectangular coordinate, semilog, or log paper. The program also provides statistical information that is useful in appraising how well the line fits the data points, the degree of correlation between x and y, and the confidence interval or limits. Additionally, the program provides information for the analysis of the individual observed data points. (Author)

AD-748 204/CP PC **A03**/MF **A01**
Stanford Univ Calif Operations Research House
A Quick Method for Evaluating Causal Models
Technical rept.
M. A. Pollatschek. Jul 72, 31p Rept no. TR-72-12
Contract N00014-67-A-0112-0011, AT(04-3)-326
Sponsored in part by National Science Foundation, Grant NSF-GP-31393.

Descriptors: *Behavior, Mathematical models, Multivariate analysis, Statistical distributions, Computer programs, Graphics.
Identifiers: *Causal analysis, *Graph theory.

An evaluation scheme is presented for causal models following Blalock's and Simon's approach. The scheme is very quick even for high number of variables. Several possibilities of practical use are discussed with numerical examples. (Author)

AD-749 044/CP PC **A05**/MF **A01**
Naval Postgraduate School Monterey Calif
Application of Discrete Walsh Functions to Digital Filter Techniques
Master's thesis
Norman Clare Meck. Jun 72, 80p*

Descriptors: *Functions, Matrix algebra, Integral transforms, Fourier analysis, Digital computers, Computer programs, Sampling, Power spectra, Theses.
Identifiers: *Walsh functions, Walsh transformation, Digital filters, *Applications of mathematics, Hadamard matrix, Periodic functions.

Methods of generating and properties of Walsh functions are discussed with emphasis on discrete Walsh functons. Hardware and software versions of two methods of Walsh function generation are shown. The Walsh transform is explored and hardware and software realizations of a fast Walsh transform algorithm, particularly applicable to hardware, is introduced. Computer programs containing the various algorithms are included. A discussion of the feasibility of the use of Walsh functions to produce a digital filter with a desired frequency response is presented. (Author)

AD-749 707/CP PC **A03**/MF **A01**
Naval Academy Annapolis Md
The Development of a Linear/Dynamic Program to Optimize the Sixth Fleet Logistic Force Scheduling
Research rept.
Lawrence R. Albert. 30 May 72, 30p Rept no. USNA-TSPR-24
Report on A Trident Scholar Project.

Descriptors: *Naval vessels(Combatant), Refueling, *Scheduling, Refueling, Linear programming, Dynamic programming, Mathematical models, Simplex method, Computer programs, Algorithms.
Identifiers: Transportation models, Duality theory, Trident scholar project.

An attempt has been made to make up a schedule for the oilers in their complicated task of refueling the Sixth Fleet Combatant Force through the development of a linear/dynamic program. Linear programming efficiency and the exactness of a transportation model were combined in an approach to the problem based on a binary methodology. It was necessary to develop a means of introducing sequencing essential to the problem, to the simplex algorithm, which was accomplished through the use of a series of logic constraint. The program successfully solved small scale problems through the use of a combination of the simplex, Gomory's cutting-plane and the dual-simplex algorithms. However, before the final solution was generated, computer round-off error destroyed the convergence of the algorithms. (Author)

AD-751 233/CP PC **A04**/MF **A01**
Universal Data Systems Inc Westminster Calif
Hilbert Space Techniques for Terrain Data Representation
Christopher F. Ellis. 1971, 68p
Contract DAAG05-71-M-5237

Descriptors: *Terrain, Functional analysis, *Computer programs, Instruction manuals, Hilbert space, Cauchy problem, Data processing systems, Mapping, Integration, Transformations(Mathematics), Complex variables, Analytic functions, Fourier analysis, Matrix algebra, Vector spaces.
Identifiers: HILCON computer program, Dirichlet integral, Numerical integration, Trigonometric functions, FORTRAN, UNIVAC 1108 computers.

The report presents the results of a theoretical study whose purpose has been to investigate techniques for creating functional representations of discrete data sets, using generalized Hilbert space methods. A primary motivation of the study is the possibility of using such functional representations in place of large discrete data sets, to obtain intermediate values of functions and their partial derivatives in large-scale system simulation. A particular application of functional representations is the modeling of terrain elevation data, in which case it is highly desirable to have a functional form characterized by a relatively small number of terms that can reproduce elevation values with a high degree of accuracy. The report contains an axiomatic discussion of Hilbert space functional representations, and it also presents the results of a sequence of runs with several versions of the HILCON program, which was designed to generate the representations corresponding to specific sets of discrete terrain elevation data. (Author)

AD-751 660/CP PC **A03**/MF **A01**
Massachusetts Univ Amherst
Computational Principles of Choicegroup Generation for Selective Menus
Technical rept.
Joseph L. Balintfy, and Prabhakant Sinha. Oct 72, 48p Rept no. TR-5
Contract N00014-67-A-0230-0006

Descriptors: *Decision theory, *Food, Population(Mathematics), Matrix algebra, Mathematical models, Probability density functions, Scheduling, Optimization.
Identifiers: Menus, Food services management, *Menu planning, CGDP computer program.

A computational procedure is presented to explore and formulate the quantitative relations between the preference distribution of a population for menu items and a corresponding set of optimum choicegroups on a selective menu schedule. The investigation is limited to the decision rules applicable for the determination of a single choicegroup, and it is carried out in two stages. First, it is shown that for any preference matrix a unique process of choicegroup augmentation exists with the properties that the augmented choicegroup will provide a maximum increase in population preferences along with the probability estimates of selections. Second, it is shown that if the preference matrix is updated in the function of time and predicted selections, a multistage process of chocie-

group generation can determine a sequence of choicegroups with optimal properties of concerning the size or preference contribution involved. A computer program which operates on these principles is attached, and is used for column generating functions of constrained optimization models of selective menu scheduling. (Author)

AD-752 029/CP PC **A02**/MF **A01**
George Washington Univ Washington D C Program in Logistics
A Brief Exposition on Man-Computer Dynamic Scheduling Systems
W. L. Wilkinson. 31 Oct 72, 14p Rept no. Serial-T-272
Contract N00014-67-A-0214-0001

Descriptors: *Operations research, *Programming(Computers), Transportation, Networks, Mathematical models, Flow charting, Scheduling, Optimization.
Identifiers: *Network flows, Transportation models.

Three iterative man-computer dynamic scheduling systems are described. The object of a family of systems is twofold: to promote flexibility to embrace a variety of problems and to provide selectivity in the computational tool to economize on computer time. By taking full advantage of man's cognition, one can often solve theoretically difficult problems with the aid of comparatively simple algorithms. A typical problem area is in the testing of multimodal transport plans for feasibility and greater productivity. The automated part, composed of an integrated set of network algorithms, produces a tailored set of optimal alternative routes for selection. Man, then, reacts to this computer output at intervals of his own choosing, making decisions in terms of route selections which reflect his availabilities and delivery requirements. The process is then repeated until all requirements are met or until infeasible conditions are encountered. (Author)

AD-752 758/CP PC **A04**/MF **A01**
Texas Univ Austin Center for Cybernetic Studies
An Improved Version of the Out-of-Kilter Method and a Comparative Study of Computer Codes
Research rept.
R. S. Barr, F. Glover, and D. Klingman. Nov 72, 56p Rept no. CS-102
Contract N00014-67-A-0126-0008, N00014-67-A-0126-0009
Prepared in cooperation with Colorado Univ., Boulder.

Descriptors: *Linear programming, Algorithms, Networks, Mathematical models, Transportation, Topology, Programming(Computers), Statistical analysis, Optimization.
Identifiers: Out of kilter algorithm, Duality theory, Transportation models, Network flows, FORTRAN, FORTRAN 4 programming language.

The primary objectives of the paper are fourfold: To present an improved formulation of the out-of-kilter algorithm; To give the results of an extensive computational comparison of a code based on this formulation with three widely-used out-of-kilter production codes; To study the possible sensitivity of these programs to the type of problem being solved; To investigate the effect of advance dual start procedures on overall solution time. (Author)

AD-753 116/CP PC **A05**/MF **A01**
Dayton Univ Ohio Research Inst
Visit Allocation Model. Volume III. Algorithm Modifications
Technical rept. Aug 71-Aug 72
Arthur Z. Kovacs, and Michael J. Gehrlich. Jun 72, 95p UDRI-TR-72-36, ASD-R-72-6
Contract F33615-72-C-1049

Descriptors: *Operations research, *Programming(Computers), Permutations, Regression analysis, Least squares method, Graphics, Curve fitting, Digital computers, Transformations, Mathematical models, Transportation, Vehicles, Algorithms.
Identifiers: Visit allocation model, FORTRAN, FORTRAN 4 programming language, IBM 7094 computers, CDC 6600 computers, Transportation models.

The report contains the development and the program description of additions and modifications to the Visit Allocation Model. The Visit Allocation Model is designed to assign ordered visit site points to paths in such a manner as to include all visit sites and to minimize the total path distance subject to constraints on (1) maximum allowed path distance (range) associated with each vehicle. (2) maximum number of visits associated with each given vehicle, and (3) total number of vehicles available. Vehicles with different maximum range and visit capabilities are allowed. Each path must originate at any one of a specified group of entry points (points of origin) and must terminate at any one of a specified group of entry points (points of destination). No geometric constraints are placed upon entry, exit, or visit sites allowed; and no restriction is placed upon the number of vehicles assigned to any entry or exis. The FORTRAN 4 program was converted from the IBM 7094 Direct Couple System to the CDC 6600 computer. The new program version uses an improved algorithm to find minimum path length. (Author)

AD-753 585/CP PC **A03**/MF **A01**
Naval Postgraduate School Monterey Calif
A Comparison of Classical and Bayesian Methods for Determining Lower Confidence Limits on System Reliability
Master's thesis
Gary Lee Kirk. Sep 72, 49p

Descriptors: *Reliability, *Confidence limits, Random variables, Probability density functions, Statistical tests, Computer programs, Theses, Systems engineering.
Identifiers: Bayesian analysis, Beta function, Computerized simulation.

A series system is simulated to obtain lower confidence limits on system reliability using Bayesian techniques. A comparison between classical and Bayesian methods is made. Random beta variate generators are developed and used in the simulation. The results of the simulation are tabulated for easy comparison of the Bayesian and classical methods. The values of lower confidence limits that are realized using the Bayesian method decrease as the number of components increase. In most cases, as the number of components increase, the Bayesian method appears to yield lower values of lower confidence limits than the classical method.

AD-753 627/CP PC **A03**/MF **A01**
Naval Postgraduate School Monterey Calif
The Use of Known Classical System Reliability Estimation Methods to Approximate the Final Solution in Bayesian Methodology
Master's thesis
David W. Mattis. Sep 72, 44p

Descriptors: *Reliability, *Confidence limits, Mathematical models, Random variables, Probability density functions, Statistical tests, Graphics, Curve fitting, Computer programs, Theses.
Identifiers: Bayesian analysis, Beta function, Computerized simulation, Chi square test.

The thesis examines three methods for calculating the 100(1-alpha)% lower confidence limits for the reliability of a K-sized series system. Assuming that each component reliability has a Beta distribution, identical posterior parameters A and B are assigned for each component. (Author)

AD-753 915/CP PC **A05**/MF **A01**
New Mexico Univ Albuquerque
The Method of Summary Representation
Technical rept. Jul 66-Jun 67
M. D. Bradshaw. Dec 72, 77p* AFWL-TR-72-129
Contract AF29(601)-7097

Descriptors: *Partial differential equations, Numerical analysis, Difference equations, Integral transforms, Conformal mapping, Fourier analysis, Approximation(Mathematics), Matrix algebra, Geometry, Computer programs, Potential theory, Integration.
Identifiers: Finite difference theory, *Laplace equation, Applications of mathematics, Tridiagnol matrices, Box computer program, DIELBOX computer program, Numerical integration, Harmonic functions.

The report describes a new mathematical technique for solving partial differential equations developed by G. N. Polozhii. The technique is illustrated by applying it to the solution of Laplace's equation in rectangular coordinates. The method of summary representation combines elements of commonly used analytical and finite difference techniques. Designed specifically for computer applications, the new technique is based upon the special properties of tridiagonal matrices. Use of the method of summary representation allows the general solution to be written down in a finite difference form especially suited for computation. Advantages of the new technique include the capability for calculating values at any selected point in the grid and provision for higher accuracy than conventional techniques. In addition, changes in the boundary conditions are very easily incorporated. Problems which can be described in rectangular geometry, including irregular shapes, are discussed. Specific numerical examples are given for four one-region situations and seven two-region situations. (Author)

AD-753 990/CP PC **E06**/MF **E03**
Georgia Univ Athens Dept of Statistics and Computer Science
On the Exact Distribution of Convolutions of a Truncated Gamma Distribution
Technical rept.
Rolf E. Bargmann, and Hubert Bouver. Jul 72, 220p TR-88, THEMIS-UGA-21, CPG-73-0039
Contract N00014-69-A-0423

Descriptors: *Statistical distributions, *Computer programs, Random variables, Probability density functions, Integral transforms, Fourier analysis, Analytic functions, Integration, Curve fitting, Graphics, Subroutines, Theses.
Identifiers: *Gamma function, FORTRAN, IBM 360/65 computers, FORTRAN 4 programming language, Fourier transformation, Themis project.

The report presents the derivation of formulas, development and documentation of computer programs, for the distribution of the sum of truncated, independent and identically distributed, gamma random variables. The derivation for the cumulative distribution function of the sum of independent, right-truncated, gamma variables is given in detail. The final formula for the left truncation was stated without derivation since it was a special case of the double truncated which was also derived in detail. IBM 360/65 FORTRAN 4 computer programs have been developed which evaluate the cumulative distribution function of the sum of independent gamma variables. (Author)

AD-754 003/CP PC **E02**/MF **A01**
Aerospace Research Labs Wright-Patterson AFB Ohio
A Simple Computer Program for Solving the Abel Integral Equation
A. M. Hunter, II, and P. W. Schreiber. Aug 72, 33p ARL-72-0106, CPG-73[illegible]040

Descriptors: *Integral equations, *Programming(Computers), Numerical analysis, Gas flow, Plasma physics, Enthalpy, Computer programs.
Identifiers: *Abel equation, Abel inversion, MIMIC programming language, Applications of mathematics, CDC 6600 computers.

The objective of this analytical study is to provide a simple computer program to reduce externally measured optical data from axi-symmetric sources to internal state distributions. This is achieved by using MIMIC program language to write a short, easily applied program to perform the Abel inversion. Clear and complete instructions are given so that any person may use the program to reduce experimentally determined lateral profiles to radial internal distributions. (Author)

AD-754 012/CP PC **A07**/MF **A01**
Institute for Defense Analyses Arlington Va Systems Evaluation Div
Identification of Data Structures and Relationships by Matrix Reordering Techniques
Final rept.
William T. McCormick, Jr, Stephen B. Deutsch, John J. Martin, and Paul J. Schweitzer. Dec 69, 143p P-512, IDA-HQ-69-10829

Descriptors: *Data processing systems, Matrix algebra, Permutations, Moments, Algorithms, Computer programs, Optimization, Pattern recognition, Experimental design, Multivariate analysis, Algorithms.
Identifiers: *Data structures.

The paper presents the results of a study conducted to develop algorithms for ordering and organizing data that can be presented in a two-dimensional matrix form. The purpose was to develop methods to extract latent data patterns, groupings, and structural relationships which are not, in general, apparent from raw matrix data. (Author)

AD-754 090/CP PC **A02**/MF **A01**
Georgia Univ Athens Dept of Statistics and Computer Science
A Generalized Product Rule for the Triangle
Technical rept.
Frank G. Lether. Jun 72, 22p Rept nos. TR-82, THEMIS-UGA-20
Contract N00014-69-A-0423

Descriptors: *Integrals, *Approximation(Mathematics), Transformations(Mathematics), Convergence, Integration, Computer programs, Numerical analysis.
Identifiers: Triangles, Numerical integration, FORTRAN, Themis project.

The purpose of the technical report is to present a technique for approximating the double integral of a function of two variables over a triangle. A FORTRAN program and some numerical examples are given which employ the numerical integration rule derived in the report. (Author)

AD-754 346/CP PC **A03**/MF **A01**
Naval Postgraduate School Monterey Calif
A Computerized Algorithm for the Determination of the Optimal Allocation of Two Weapons Systems Against N Targets
Master's thesis
James Frederick Amerault. Sep 72, 30p

Descriptors: *Weapon systems, Effectiveness, *Nonlinear programming, Algorithms, Mathematical models, Search theory, Target recognition, Computer programs, Optimization, Theses.
Identifiers: *Allocation models, FORTRAN, IBM 360 computers.

The problem of allocating munitions from M weapons systems to N target complexes is studied and a review of pertinent literature is presented. An algorithm for the solution of the problem in the special case of two weapons systems against N targets is developed and programmed for computerized solution. The results of an example problem are shown and tested. Discussion of the algorithm's extension to more than two weapons systems is included as are alternative solution techniques. (Author)

AD-754 347/CP PC **E01**/MF **A01**
Naval Postgraduate School Monterey Calif
An Evaluation of the TRW Method of Combining Point Estimates of Reliability
Master's thesis
Robert Emmett Sheridan. Sep 72, 33

Descriptors: *Reliability, *Statistical analysis, Probability density functions, Tables, Computer programs, Theses.
Identifiers: Point estimates.

A computer program was written that carries out reliability assessments according to a method proposed by the TRW Corporation. This method combines point estimates for reliability from different sources into an overall point estimate. The program was used to calculate the overall point estimate for cases covering a range of sample sizes, and underlying probabilities of success in order to make a judgement on the usefulness of the method. (Author)

AD-754 583/CP PC **A16**/MF **A01**
Research Analysis Corp Mclean Va
CONFORM: Constrained Force Model. Volume II. Detailed Model Description, Program Documentation, and Operator's Guide
Final rept.
Richard H. Gramann, G. Robert Doenges, Jr, and W. Bruce Taylor. Dec 72, 359p Rept no. RAC-R-151-Vol-2
Contract DAHC19-69-C-0017
See also Volume 1, AD-754 582.

Descriptors: *Logistics, Army operations, *Army operations, Mathematical models, *Army personnel, Military requirements, *Linear programming, Optimization, Mission profiles, Combat readiness, Management planning, Computer programs, Instruction manuals.
Identifiers: CONFORM(Constrained Force Model), Constrained force model, *Force structure, Goal programming, Allocation models, FORTRAN 4 programming language, FORTRAN, IBM 360 computers.

The Constrained Force Model, CONFORM, is designed to assist force planners in the task of adjusting proposed theater troop lists to satisfy troop ceilings, fiscal and other constraints. The model is especially suited for troop list evaluations and analyses concerned with support allocation role, constrained force design, support shortfalls and theater force costing. The volume contains a detailed model description, program documentation, and operator's guide. (Author)

AD-755 144/CP PC **A14**/MF **A01**
Research Analysis Corp Mclean Va
The Army Systems Phasing Model: A Methodology for Optimization Over Time. Volume II. Chapter 4 and Appendices
Technical paper
Charles A. Allen, Ronald G. Magee, W. Charles Mylander, Ronald New, and John D. Pearson. Jan 73, 308p Rept no. RAC-TP-457-Vol-2
Contract DAHC19-69-C-0017
See also Volume 1, AD-755 143.

Descriptors: *Army budgets, Advanced planning, *Nonlinear programming, Algorithms, *Computer programs, Instruction manuals, Management planning, Mathematical models, Costs, Compilers, Matrix algebra.
Identifiers: Resource allocation, Branch and bound method, FORTRAN, Constraints.

The report describes a non-linear programming model for application to long range planning problems of the resource allocation type. A significant characteristic of the methodology is that time-phased acquisition and disposition of systems is explicitly considered in the optimization. Volume 2 provides an operational description of the computer program, sample problems, program flow charts, and program listings. (Author)

AD-755 366/CP PC **A05**/MF **A01**
Carnegie-Mellon Univ Pittsburgh Pa Dept of Computer Science
The Design Problem Solver, A System for Designing Equipment or Furniture Layouts
Charles E. Pfefferkorn. Sep 72, 92p* AFOSR-TR-73-0155
Contract F44620-70-C-0107
Prepared in cooperation with Purdue Univ., Lafayette, Ind. Dept. of Computer Sciences.

Descriptors: *Programming(Computers), Problem solving, *Artificial intelligence, Mathematical logic, Mathematical models, Convex sets, Topology, Graphics, Statistical analysis, Design, Optimization, Theses.
Identifiers: *Computer aided design, Heuristic methods, Macroprogramming, Trees(Mathematics), *Space planning, *Layout problem, Convex polygons.

The Design Problem Solver (DPS) demonstrates that the computer can perform simple design tasks. In particular, it designs furniture and equipment layouts. This task was chosen because it is simple, well defined, and characteristic of many design tasks in architecture, engineering, urban planning, and natural resource management. These space planning tasks usually involve manipulating two-dimensional representations of objects, to create feasible or optimal solutions for problems involving topological and metric spatial constraints. DPS is a heuristic problem solver with a planning phase prefixed to it. It uses the planning process to give it a sense of direction, diagnostic procedures to locate difficulties, and remedial actions to recover from difficulties. It uses a convex polygon representation to accurately describe the objects and the layout. This representation allows topological and metric constraints to be tested and the design to be easily updated. (Author)

AD-755 437/CP PC **A04**/MF **A01**
Air Force Weapons Lab Kirtland AFB N Mex
A Discussion of Gear's Implementation of Adam's and Stiff Methods for Solving Ordinary Differential Equations
Technical rept. 1 Jul 71-30 Jun 72
Charles M. Walters. Nov 72, 63p Rept no. AFML-TR-72-170

Descriptors: *Nonlinear differential equations, Integration, *Computer programs, Nonlinear differential equations, Initial value problems, Matrix algebra, Transformations(Mathematics), Difference equations, Algorithms.
Identifiers: Stiff differential equations, Applications of mathematics, Truncation errors, FORTRAN, DIFSUB computer program, FORTRAN 4 programming language, Ordinary differntial equations, CDC 6600 computers.

The report discusses the methods used in Air Force Weapons Laboratory (AFWL) subroutine DIFSUB, a subroutine design to solve a system of first order, nonlinear, ordinary differential equations (ODEs). This subroutine contains two types of methods--the methods developed C. W. Gear for solving systems of stiff equations and Adams methods for solving systems of nonstiff equations. A detailed discussion of both the Adams and stiff methods and how they are embodied in DIFSUB is presented. DIFSUB is written in FORTRAN 4 for CDC 6600 computers. Program listings are included.

AD-755 878/CP PC **A03**/MF **A01**
Alabama Univ Huntsville Research Inst
Computer Program for Solution of Large, Sparse, Unsymmetric Systems of Linear Equations
Research rept.
John E. Key. Aug 72, 35p UARI-RR-130, AFOSR-TR-73-0220
Contract F44620-69-C-0124

Descriptors: *Matrix algebra, Simultaneous equations, *Computer programs, Matrix algebra, Computer storage devices, Determinants, Transformations(Mathematics).
Identifiers: Linear algebraic equations, FORTRAN 4 programming language, Sparse matrix, FORTRAN, Finite element analysis.

A computer program written in FORTRAN IV symbolic language for the in-core solution of large, sparse, unsymmetric systems of linear equations is presented. The efficiency of this program with respect to computer storage and arithmetic operations depends upon the system of equations at hand and the technique adopted for selecting the pivotal element are included so that the program user can choose the technique which appears to be suitable for the system of equations under consideration. (Author)

AD-756 402/CP PC **A03**/MF **A01**
Watervliet Arsenal N Y
Computation of Smooth Contours from Non-Uniform Data
Technical rept.
Richard Bair. Dec 72, 42p Rept no. WVT-7265

Descriptors: *Interpolation, Functions, *Numerical analysis, *Computer programs, Curve fitting, Algorithms, Analytic functions.
Identifiers: Spline functions, *Spline interpolation, FORTRAN, NASTRAN computer program, Computation.

A computational procedure to obtain smooth contours from discrete input data is presented. Contours are tracked, using traditional root-finding methods, across a piecewise doubly cubic spline surface. A FORTRAN program implements this method and runs in under 80K bytes storage. Representative graphical results are included. (Author)

AD-756 518/CP PC **A03**/MF **A01**
Naval Postgraduate School Monterey Calif
Evaluation of the Accuracy of a Lower Confidence Limit Estimate for Series System Reliability
Master's thesis
Samuel Hall Evans. Sep 72, 45p

Descriptors: *Reliability, *Confidence limits, Random variables, Statistical tests, Probability density functions, Malfunctions, Sampling, Computer programs, Theses, Mathematical models.
Identifiers: Computerized simulation, Bayesian estimation, Computation.

The purpose of the study is to evaluate the accuracy of a procedure used to compute an estimate of the lower 100(1-gamma)% confidence limit for reliability of system of independent components connected in logical series. The procedure takes a Bayesian approach and uses test data on the individual components where the sample sizes may be unequal and no knowledge of the component failure distribution is needed. A computer simulation is used to generate test failure data and to compute estimates for the lower 100(1-gamma)% confidence limit on system reliability. (Author)

AD-756 536/CP PC **A03**/MF **A01**
Naval Postgraduate School Monterey Calif
Comparison of a Deterministic and a Stochastic Model for the Probability of Winning in a Two-Sided Combat Situation
Master's thesis
Woo Young Lee, and Amnuay Wannasilpa. Sep 72, 43p

Descriptors: *Armed Forces operations, *Lanchester equations, *Game theory, Stochastic processes, Mathematical models, War games, Attrition, Differential equations, Curve fitting, Graphics, Computer programs, Theses.
Identifiers: Markov processes.

Combat attrition can be modelled as either a deterministic or a stochastic process. In the thesis the forecasts of combat outcomes generated by deterministic and stochastic Lanchester-type models for combat between two homogeneous forces are compared. Using stochastic formulations, the probability of winning is studied and contrasted with a deterministic win criterion for some idealized combat situations. Force ratios required to assure victory in an attack are studied from this standpoint. (Author)

AD-757 025/CP PC **A05**/MF **A01**
Wisconsin Univ Madison Dept of Statistics
Chernoff Efficiency of Linear Rank Statistics
Technical rept.
Tea-Yuan Hwang. Dec 72, 76p Rept no. UWIS-DS-72-318
Contract N00014-67-A-0128-0017, Grant AF-AFOSR-1803-69
Sponsored in part by National Science Foundation, Grant NSF-GP-12093.

Descriptors: *Statistical analysis, Theorems, Sampling, Probability, Statistical tests, Inequalities, Curve fitting, Graphics, Computer programs, Theses.
Identifiers: Chernoff efficiency, Asymptotic efficiency, Hypotheses, T test, Ranking, N.

A theorem of Hoadley used to compute large deviation probabilities for linear rank statistics with bounded score functions is extended to cover the unbounded case. The theorem is then applied to compute large deviation probabilities under alternatives in order to obtain the Chernoff efficiency of linear rank statistics. Numerical values are obtained under normal location alternatives for the two sample Wilcoxon and are shown to decrease more slowly than do corresponding Bahadur efficiency values with increasing location difference. (Author)

AD-757 153/CP PC **A03**/MF **A01**
Ballistic Research Labs Aberdeen Proving Ground Md
Accuracy of HEMP Code Solutions
Memorandum rept.
Robert R. Karpp. Jan 73, 42p Rept no. BRL-MR-2268

Descriptors: *Warheads, Design, *Programming(Computers), Warheads, Initial value problems, Numerical analysis, Explosive materials, Elasticity, Boundary value problems, Design, Mathematical models.
Identifiers: HEMP computer program, Finite difference theory, Computer aided design, A.

Results of HEMP code calculations of simple problems are compared with exact results to determine the accuracy with which this numerical technique solves initial-boundary value problems. More complicated problems of metal liners accelerated by explosives were also calculated with this code, and these results were compared with experimental results to determine how well the code simulates these physical processes. It is concluded that HEMP calculations are accurate enough to be useful as a tool for predicting the gross motion of metals accelerated by detonating explosives. (Author)

AD-757 281/CP PC **A06**/MF **A01**
Naval Postgraduate School Monterey Calif
A Three Dimensional Solution of the Transient Field Problem Using Isoparametric Finite Elements
Master's thesis
Girard Thomas Lew. Dec 72, 122p

Descriptors: *Partial differential equations, Integration, *Computer programs, Instruction manuals, Conduction(Heat transfer), Vibration, Transients, Cylindrical bodies, Theses.
Identifiers: Finite element analysis, FORTRAN 4 programming language, FORTRAN, FIELD computer program, Numerical integration, N.

An isoparametric finite element formulation solving a general form of the transient field equation is presented in this thesis. The formulation is developed for fields in three-dimensional Euclidean space. A FORTRAN IV computer program employing double precision arithmetic, compact storage techniques, and providing the option of several numerical integration methods and types of finite elements in presented. Data input may be in rectangular, cylindrical, or spherical coordinates and variations in time integration step size are permitted. Time dependent boundary conditions are not considered. Comparisons of theoretical and computer solutions for a variety of test problems demonstrate close agreement. Instructions for use of the program are included. (Author)

AD-757 349/CP PC **A02**/MF **A01**
Naval Postgraduate School Monterey Calif
Large-Scale Computer-Aided Statistical Mathematics
Technical rept.
Peter A. W. Lewis. Nov 72, 20p Rept no. NPS-55LW72111A

Descriptors: *Statistical analysis, *Programming(Computers), Random variables, Distribution functions, Multivariate analysis, Interfaces.
Identifiers: Computer aided analysis, Multiprogramming, Computerized simulation, Jackknife method, Estimation theory, N.

Some thoughts on large-scale computer-aided statistical mathematics (primarily simulation) which were presented at the 6th Annual Conference on the Computer Science/Statistics interface conference are presented. (Author Modified Abstract)

AD-757 350/CP PC **A04**/MF **A01**
Houston Univ Tex Dept of Mechanical Engineering
Functional Analysis Using Walsh Functions
Technical rept.
Paul A. Coppinger. Dec 72, 62p* Rept no. TR-33
Contract N00014-68-A-0402-0003

Descriptors: *Functional analysis, Special functions(Mathematical), Integral transforms, Fourier analysis, Harmonic analysis, Difference equations, Least squares method, Spectrum analyzers, Pattern recognition, Information theory, Phase-locked systems, Computer programs, Mathematical models.
Identifiers: *Walsh functions, Signal processing, *Orthogonal functions, Computerized simulation, Fourier transformation, Spectrum analysis, N.

Functional analysis usually implies representing a signal by a series of sine-cosine functions, but is actually included in the much broader problem of decomposition, that is, separating an arbitrary signal into preferred component signals. The most common approach to decomposition still uses a complete orthogonal set of functions, such as sine-cosine functions or Bessel functions, and an integral transform. In recent years, much attention has been given to a relatively unknown set of orthogonal functions, the Walsh Functions. A general discussion of orthogonal functions and series expansion, and some of the properties of Walsh Functions are presented followed by the necessary theory to determine the component coefficients of linearly composed signals. The theory employs an integral transformation using Walsh Functions and a matrix transformation yielding a least-square-fit approximation. (Author Modified Abstract)

AD-757 357/CP PC **A04**/MF **A01**
Florida Univ Gainesville Dept of Industrial and Systems Engineering
A Shop Model for a Naval Air Rework Facility
Research rept.
Christopher B. Haas, and Thom J. Hodgson. 31 Jan 73, 60p Rept no. RR-73-9
Contract N00014-68-A-0173-0013

Descriptors: *Decision theory, Stochastic processes, *Scheduling, Manpower, *Naval aircraft, Maintenance, Hydraulic systems, Costs, Production control, Queueing theory, Probability density functions, Spare parts, Inventory control, Optimization, Computer programs, Naval Air Stations.
Identifiers: Markov decision processes, Markov processes, *Job shop scheduling, Job scheduling, Histograms, Digital simulation, Naval Air Rework Facilities, Jacksonville Naval Air Station, N.

In the paper a model of a hydraulic shop in a naval air rework facility is developed. First, job flows within the shop are identified. Then, the various mechanisms controlling job flow are quantified. This formulation is made in terms of the standard manhours of work in the system rather than the more traditional approach which deals with the number of jobs in the system. The system cost structure is presented. Finally, the model is formulated as a Markov decision process. Analysis of the structure of the optimal decision policy for the model reveals an interesting characteristic. The control structure has inertia (i.e., there is a reluctance to change the current policy in effect until it becomes absolutely necessary to do so). (Author)

AD-757 479/CP PC **A03**/MF **A01**
Wisconsin Univ Madison Dept of Statistics
D-Optimal Designs for Dynamic Models. Part II. Applications
Technical rept.
Bernard Viort. Nov 72, 43p Rept no. UWIS-DS-72-316
Grant AF-AFOSR-2363-72

Descriptors: *Experimental design, Statistical analysis, Mathematical models, Analysis of variance, Matrix algebra, Optimization, Computer programs.
Identifiers: AF.

In a preceding report (D-Optimal Designs For Dynamic Models, Part 1) some results on the theory of C-constrained D-optimal designs were presented. The present report is intended to be an illustration of the methods proposed: the consideration of different examples raises some interesting questions and remarks concerning both the theoretical situation considered in the previous report and the possible applications. The numerical methods developed in relation with the notion of D-optimality allow for a greater flexibility in judging the overall quality of a design, suggesting the need for a more general theory. (Author Modified Abstract)

AD-757 606/CP PC **A05**/MF **A01**
Army Missile Command Redstone Arsenal Ala Systems Engineering Directorate
Reliability Analysis of Unpaced Visual Inspection Tasks
Technical rept.
Robert G. Wilson. 15 Mar 73, 96p Rept no. RC-73-1

Descriptors: *Reliability, *Statistical analysis, *Quality control, Performance(Human), *Visual inspection, Performance(Human), Probability density functions, Statistical tests, Errors, Acceptability, Computer programs.
Identifiers: Gamma density functions, Lognormal density functions, Normal density functions, Weibull density functions, Exponential density functions, A.

The research was directed toward application of classical hardware reliability analysis methods to describe human performance error rates on discrete tasks. The specific problem investigated was the mathematical formulation needed to describe the probability of human error associated with discrete unpaced, visual inspection tasks. Knowledge of the inspector's perception of the percentage defective, his ability to numerically express his perception, and the effect of a dynamic environment on each were several secondary objectives which impacted this research and which needed to be investigated. Ten subjects were laboratory tested, with the number of items to first error, items between errors, defects to first error, and defects between errors recorded. Through classical inference theory, the underlying distributions of errors were investigated. (Author Modified Abstract)

AD-757 643/CP PC **E01**/MF **A01**
Naval Ship Research and Development Center Bethesda Md
FORTRAN Subroutines for the Expansion of a Probability Density in a Gram-Charlier Series
Research and development rept.
F. J. Garner, and S. Berkowitz. Aug 72, 41 Rept no. NSRDC-3848

Descriptors: *Programming(Computers), Probability density functions, Polynomials, Series, Time series analysis, Computer programs.
Identifiers: Gram-Charlier series, FORTRAN, IBM 7090 computers, CDC 6700 computers, Hermite functions, N.

The report documents two FORTRAN subroutine packages (implemented on the IBM 7090 and CDC 6700), GRAMCO and HERPO, that generate values for Gram-Charlier series coefficients and Hermite polynomials, respectively, where the coefficient and polynomial may have arbitrary order and as many as seven dimensions. The subroutines implement recurrence relations developed at the Naval Ship Research and Development Center by Dr. S. Berkowitz which generate the polynomials and coefficients without using partial differentiation. The routines employ an efficient algorithm which specifies the minimal set of lower-ordered coefficients of polynomials needed to compute a requested coefficient or polynomial value. (Author)

AD-757 985/CP PC **A03**/MF **A01**
Texas Univ Austin Center for Cybernetic Studies
Double-Pricing Dual and Feasible Start Algorithms for the Capacitated Transportation (Distribution) Problem
Research rept.
Fred Glover, D. Karney, and D. Klingman. Oct 72, 27p Rept no. CS-105
Contract N00014-67-A-0126-0008, N00014-67-A-0126-0009

Descriptors: *Linear programming, Algorithms, Programming(Computers), Mathematical models, Transportation, Networks.
Identifiers: *Transportation models, *Network flows, OPHELIE/LP computer code, FORTRAN 4 programming language, FORTRAN, N.

The primary objectives of this paper are: (1) to present a simplified 'double-pricing' method for solving the capacitated transportation problem by Lemke's dual method which streamlines computer implementation; (2) to give a new and efficient method for obtaining a dual feasible starting basis; (3) to give the results of computational comparison of a code based on these developments with two widely used out-of-kilter production codes. In addition, these codes are compared against a state of the art large scale LP code, OPHELIE/LP. The study shows that the improved dual transportation algorithm is faster than the out-of-kilter codes for problems of up to 150 x 150 (origins x destinations), but tends to fall behind thereafter. The best algorithms was found to be at least 20 times faster than OPHELIE. (Author)

AD-758 523/CP PC **A09**/MF **A01**
Naval Postgraduate School Monterey Calif
Analysis of the Jackknife Method Using Straight and Antithetic Realizations from a Computer Simulation
Master's thesis
Charles Andrew Lusky. Dec 72, 182p

Descriptors: *Queueing theory, Statistical analysis, Mathematical models, Confidence limits, Statistical tests, Pseudo-random systems, Computer programs, Tables, Theses.
Identifiers: Jackknife method, Computerized simulation, Weibull density functions, Robust procedures, N.

In many situations it is important to have a continuous flow of supplies from a storage point to a consumer. Often, though, queues develop and the flow of supplies is interrupted. To investigate these queue problems the statistics concerning various queue properties may be studied by computer simulation. To obtain accurate statistical information many realizations for each queue property must be obtained. Because of this, it may be costly to use queue simulations and computers to study these problems. However, by using straight-forward and antithetic sampling techniques in a queue simulation, the number of realizations needed to obtain accurate confidence interval estimates for the population standard deviation (Sigma sub P) was reduced. By using a combination of ten straight and ten corresponding antithetic realizations, repeated testing of confidence intervals determined by both the jackknife and chi-square procedures showed that the predicted percentage of coverage of (sigma sub p) for the various queue properties could be obtained to a satisfactory approximation. (Author)

AD-758 673/CP PC **A03**/MF **A01**
Naval Postgraduate School Monterey Calif
Computational Technology for Comparison of Two Methodologies for Position Finding Search Regions
Master's thesis
Linn Tyler Shoup. Dec 72, 33p

Descriptors: *Position finding, Mathematical models, *Search theory, Position finding, Direction finding, Confidence limits, Statistical tests, Computer programs, Theses.
Identifiers: Computerized simulation, Chi square test, FORTRAN, N.

The thesis considers two models for the computation of position finding confidence, one of which uses a bivariate normal distribution of region, and the other a chi-square distribution. The two models are based on different assumptions, these are explained and explored. A computer simulation model is presented which uses both position finding models under varying conditions. (Author)

AD-758 824/CP PC **A03**/MF **A01**
Center for Naval Analyses Arlington Va
User's Guide for Generalized Factor Analysis Program (FACTAN)
Peter H. Stoloff. Feb 73, 45p Rept no. CNA-Professional Paper-106

Descriptors: *Factor analysis, Programming(Computers), Random variables, Correlation techniques, Regression analysis, Matrix algebra.
Identifiers: FACTAN computer program, SD.

The factor analytic model and its uses are discussed. A detailed description of program card preparation, computational procedures and an example run are provided. (Author)

AD-758 826/CP PC **A02**/MF **A01**
Center for Naval Analyses Arlington Va
Relating Factor Analytically Derived Measures to Exogeneous Variables
Peter H. Stoloff. Mar 73, 23p Rept no. CNA-Professional Paper-107

Descriptors: *Factor analysis, Correlation techniques, Matrix algebra, Measure theory, Regression analysis, Computer programs.
Identifiers: N.

The paper presents a method by which factors and exogeneous variables can be correlated without the numerically cumbersome process of computing factor scores. (Author)

AD-758 985/CP PC **A04**/MF **A01**
Naval Ammunition Depot Crane Ind Quality Evaluation and Engineering Lab
Multiple Sampling
John G. Gilley. Mar 73, 65p Rept no. QEEL-TR-15

Descriptors: *Quality control, Sampling, *Sampling, Multiple operation, Probability, Random variables, Distribution functions, Hypergeometric functions, Defects(Materials), Computer programs.
Identifiers: Statistical quality control, Inspection, Risk, Acceptance quality levels, Hypergeometric density functions, N.

The report presents a computer program designed for use in the development of up to seven step multiple sampling plans. Fixed lot sampling using attributes is discussed for single, double, and multiple sampling approaches. The paper presents some advantages and disadvantages of using double and mutliple sampling procedures over single sampling plans. Formulas used for the double and multiple sampling procedures and examples of the calculations are given. (Author)

AD-759 122/CP PC **A03**/MF **A01**
Picatinny Arsenal Dover N J
BIDDER: A Computer Program for a Contractor Selection Problem using the Hungarian Method
Final rept.
Otto Wolf. Mar 73, 26p Rept no. PA-TM-2078

Descriptors: *Contracts, Bargaining, *Bargaining, Mathematical models, Production, Decision theory, Matrix algebra, Programming(Computers), Algorithms.
Identifiers: *Bidding, BIDDER computer program, Hungarian algorithm, A.

The computer program BIDDER was developed to optimally select contractors for a given production item from all interested manufacturers. The program assumes that the total quantity required is known. Manufacturers are asked to submit bids on the unit price for manufacturing fixed quantities of the item. In BIDDER the number of contractors to be selected is given. An efficient algorithm was developed to determine the various combinations of the fixed quantities for the required number of bids that can exactly meet the total requirements of the item. For each combination, the well-known Hungarian Algorithm is used to determine the assignment of quantities to manufacturers that will minimize the total cost (or maximize the profit). (Author)

AD-759 128/CP PC **A03**/MF **A01**
Florida Univ Gainesville Dept of Industrial and Systems Engineering
A Solution Procedure for a Rectilinear Distance Minimax Round Trip Location Problem
Research rept.
Albert W. Chan, and Donald W. Hearn. Jan 73, 43p RR-73-3, AROD-T-1:98-RT
Contract DAHC04-68-C-0002

Descriptors: *Linear programming, Minimax technique, Matrix algebra, Geometry, Optimization, Computer programs.
Identifiers: Location models, Duality theory, Constraints, Round trip distance, Network flows, A.

The problem considered is that of finding the location of a facility in the plane so that the maximum rectilinear round trip distance between the facility and N pairs of existing facilities in the plane will be minimized. The round trip distance is the total distance travelled starting from the new facility via a pair of existing facilities and back to the new facility. A solution procedure is developed for finding all optimal locations to the problem. The derivation of the procedure is based on solving a linear program which is equivalent to the minimax location problem in question. (Author)

AD-759 783/CP PC **A07**/MF **A01**
Cullen Coll of Engineering Houston Tex
Computer Aided Flow Graph Analysis
Technical rept.
Ray A. Williams, and Ernest J. Henley. Dec 72, 137p Rept no. RE-2-72
Contract N00014-68-A-0151

Descriptors: *Graphics, Mathematical models, Systems engineering, Differential equations, Transfer functions, Matrix algebra, Computer programs, Sensitivity.
Identifiers: Computer aided analysis, Flow graphs, *Network flows, Applications of mathematics, Sensitivity analysis, N.

A generalized technique for the solution of engineering problems which can be represented in the form of flow graphs has been developed. The fundamental algorithm is one whereby the paths and loops in a flow graph can be systematically and selectively enumerated. This algorithm serves as the basis for a procedure whereby Mason's rule can be efficiently applied to generate characterustic equations, system determinants, transfer functions defining input-output relationships, sensitivity functions, and other important network functions related to signal flow graphs. (Author)

AD-759 785/CP PC **A03**/MF **A01**
Maryland Univ College Park Computer Science Center
ARC Graphs and Their Possible Application to Sparse Matrix Problems
Technical rept.
Werner C. Rheinboldt, and Charles K. Mesztenyi. Apr 73, 48p Rept no. TR-238
Contract N00014-67-A-0239-0021, Grant NSF-GJ-35568

Descriptors: *Graphics, Matrix algebra, Mathematical logic, Permutations, Algorithms, Computer programs.
Identifiers: Graph theory, Sparse matrix, Boolean algebra, FORTRAN, N.

In continuation of earlier work on the graph language GRAAL for describing and implementing graph algorithms, the report introduces a new type of graph representation involving solely the arcs and their incidence relations and leaving the nodes implicitly defined. In line with the set theoretical foundation of GRAAL, the arc graph structure is defined in terms of four Boolean mapping over the power set of the arcs. A simple data structure is available for arc graphs requiring only storage of the order of the arc set itself. As an application, algorithms for the LU decomposition of a matrix and the solution of sparse linear systems are formulated in terms of arc graphs and their operators. Furthermore, the report describes a subroutine test package for experimentation with the arc graph representation, which is then used to implement and test the sparse matrix algorithms. (Author)

AD-760 358/CP PC **A03**/MF **A01**
Princeton Univ N J Dept of Statistics
Fitting an Unobserved Component Time Series Model
Technical rept.
P. Bloomfield, and T. Corwin. Jan 73, 39p Rept no. TR-24-Ser-2
Contract N00014-67-A-0151-0017

Descriptors: *Time series analysis, Mathematical prediction, Approximation(Mathematics), Convex sets, Mathematical models, Milk, Meat, Costs, Algorithms, Computer programs, Economics.
Identifiers: Stationary processes, Parameter estimation, *Prices, *Economic models, FORTRAN, N.

The paper deals with a comparison of two methods for estimating a parametric model of a linear, Gaussian time series, based upon two different approximations to the likelihood function of the process. Discussed is the estimation of the parameters of Nerlove's unobserved-component model as presented in 'Analysis of Economic Time Series by Box-Jenkins and Related Techniques', through use of two approximations to the likelihood function of a Gaussian time series.

AD-761 021/CP PC **A04**/MF **A01**
Army Materiel Command Texarkana Tex Intern Training Center
Identifying Parameters of Heterogeneously Mixed Normal Populations Using Curve Fitting Techniques
Research rept.
Stephen V. Balint. Jul 71, 72p Rept no. USAMC-ITC-2-71-25

Descriptors: *Statistical distributions, Curve fitting, *Curve fitting, Least squares method, Sampling, Population(Mathematics), Probability density functions, Partial differential equations, Computer programs.
Identifiers: Normal density functions, Parameter estimation, FORTRAN 4 programming language, FORTRAN, A.

The paper discusses the feasibility of using least squares curve fitting techniques to determine the parameters of a polymodal normal distribution. Although the attempt to program a specific method proved unworkable within the limitations of the computer facilities available, some of the preliminary techniques were very successful and the overall program provides a good foundation for further research. (Author)

AD-761 177/CP PC **A02**/MF **A01**
Stanford Univ Calif Stanford Electronics Labs
An Almost-Optimal Algorithm for the Assembly Line Scheduling Problem
Technical rept. no. 53
Marc T. Kaufman. Jan 73, 24p Rept nos. SU-SEL-73-009, STAN-CS-73-350
Contract N00014-67-A-0112-0044, Grant NSF-GK-23315

Descriptors: *Data processing systems, Scheduling, *Scheduling, Mathematical models, Multiple operation, Graphics, Inequalities, Optimization, Algorithms.
Identifiers: *Multiprocessing, Parallel processors, Trees(Mathematics), Graph theory, N.

The paper considers a solution to the multiprocessor scheduling problem for the case where the ordering relation between tasks can be represented as a tree. (Modified author abstract)

AD-761 375/CP PC **A03**/MF **A01**
Naval Postgraduate School Monterey Calif
Numerical Properties of a Boundary Crossing Process Useful in Life Testing
Master's thesis
William Herbert Gwinn. Mar 73, 42p

Descriptors: *Sampling, *Sequential analysis, *Reliability, Mathematical prediction, Life expectancy, Decision theory, Confidence limits, Computer programs, Tables, Theses, Stochastic processes, Queueing theory.
Identifiers: Computerized simulation, Order statistics, Hypotheses, *Life tests, Exponential density functions, FORTRAN, N.

An approximate boundary for a finite sample sequential decision process is presented (without derivation). By means of computer simulation, properties of the process are checked; the power of the test is thus determined for selected alternative hypotheses. (Author)

AD-761 475/CP PC **A04**/MF **A01**
Naval Postgraduate School Monterey Calif
Estimation of a Cost Function for a Naval Air Rework Facility
Master's thesis
Wilbur Cobb Trafton. Mar 73, 75p

Descriptors: *Naval shore establishments, Cost effectiveness, *Aircraft, Maintenance, Aircraft engines, Mathematical models, Linear programming, Regression analysis, Computer programs, Theses, California.
Identifiers: Naval Air Rework Facilities, *Production functions, *Penalty functions, San Diego(California), N.

The objective of the study was to estimate a cost function from a Constant Elasticity of Substitution production function and a Cobb-Douglas production function for the aircraft rework and engine repair programs at the Naval Air Rework Facility, North Island, San Diego, California. The cost functions were estimated by multiple regression analysis from data aggregated from actual data taken from production records of the two programs. An attempt was made to validate the two cost functions that were obtained, and a methodology was outlined for comparing predicted costs to actual production costs at the Naval Air Rework Facility. (Author)

AD-761 513/CP PC **A05**/MF **A01**
Naval Postgraduate School Monterey Calif
A Queuing MODEL Simulation with Dynamic Graphical Display
Master's thesis
Cyrus Michael Riddell. Mar 73, 87p

Descriptors: *Queueing theory, Stochastic processes, Statistical analysis, Computer programs, Simulation, Theses, Mathematical models.
Identifiers: Computer graphics, Computerized simulation, G/G/C queue, FORTRAN, XDS 9300 computers, CI 5000 computers, N.

The purpose of the thesis is to provide the student of queuing systems with a vehicle through which a better understanding of the interrelationships between stochastic processes and queuing systems can be achieved. (Author)

AD-761 519/CP PC **A05**/MF **A01**
Naval Postgraduate School Monterey Calif
An Analysis of Algorithms for Hardware Evaluation of Elementary Functions
Technical rept.
Richard Franke. 8 May 73, 81p Rept no. NPS-53FE73051A

Descriptors: *Functions, Numerical analysis, *Programming(Computers), Functions, Computer programs, Algorithms, Errors, Simulation.
Identifiers: Error analysis, Truncation error, Computerized simulation, N.

Algorithms for the automatic evaluation of elementary functions were studied. Available algorithms obtained from current literature were analyzed to determine their suitability for hardware implementation, in terms of their accuracy, convergence rate, and hardware requirements. The functions considered were quotient, arctangent, cosine/sine, exponential, power function, logarithm, tangent, square root, and product. (Author)

AD-761 528/CP MF **A01**
Dayton Univ Ohio Research Inst

Visit Allocation Model. Volume IV. Program Instruction Manual
Technical rept.
Arthur Z. Kovacs, Michael J. Gehrlich, and Edward C. Luczak. Nov 72, 109p UDRI-TR-72-49, ASD-R-73-3
Contract F33615-73-C-4011
See also report dated Jun 72, AD-753 116.
Availability: Available in microfiche only.

Descriptors: *Operations research, *Programming(Computers), Algorithms, Control sequences, Instruction manuals, Transformations, Statistical analysis, Transportation, Vehicles, Mathematical models, Computer programs.
Identifiers: Visit allocation model, CDC 6600 computers, IBM 7094 computers, Transportation models, FORTRAN, FORTRAN 4 programming language, TEX computer program, AF.

The visit allocation model CDC 6600 FORTRAN computer program is designed to assign visit site points to paths in such a manner as to include all visit sites and to minimize the total path distance subject to restrictions on (1) the maximum allowed path distance (range) associated with each vehicle, (2) the maximum number of visits associated with each given vehicle, and (3) the total number of vehicles available. (The program will allow for vehicles having different maximum visit capabilities). (4) Paths are further constrained to not pass through user-defined circular forbidden regions. These regions may be defined so as to overlap one another and form a barrier. (Author)

AD-761 668/CP PC A02/MF A01
University of Southern California Los Angeles Dept of Industrial and Systems Engineering
Selecting a Process Monitor Schedule with Multiple Resource Constraints
Technical rept.
Henry L. Pfister. Jun 73, 14p Rept no. TR-2
Sponsored in part by the Office of Naval Research, Arlington, Va.

Descriptors: *Data processing systems, *Scheduling, Algorithms, Time sharing, Dynamic programming, Mathematical models.
Identifiers: IBM 360/65 computers, N.

With plans to use time-sharing computers to control several simultaneous processes, the problem of scheduling the process sensors in a sample data control system is of increasing practical importance. The difficulties in scheduling arise from the necessity of sequencing optimal sensor combinations and from the optimal management of the system resources. In general the utility of a combination of sensors is not the sum of the individual utilities. Furthermore resource constraints are for long term utilization of the system. A sequencing and scheduling technique is described for this problem using a forward dynamic programming algorithm. The use of a forward algorithm allows the proof of a horizon theorem to find optimal time points to stop the scheduling process. (Modified author abstract)

AD-761 757/CP PC A03/MF A01
Naval Postgraduate School Monterey Calif
An Analysis of SERVMART Inventory Control Policies
Master's thesis
Larry Richard Atkinson. Mar 73, 42p

Descriptors: *Inventory control, Mathematical models, *Armed Forces supplies, Naval shore establishments, Stochastic processes, Distribution functions, Naval procurement, Lead time, Computer programs, Theses.
Identifiers: Navy self service retail stores, FORTRAN, Sales, Demand(Economics), N.

An investigation is made of possible inventory control policies for Navy supply system SERVMARTS (Self Service Retail Stores). Three mathematical models of the system are developed and a comparison of the solutions of these models with three current inventory control methods as applied to SERVMART demand data is presented. Based on this comparison, a stochastic, lost sales model is recommended and procedures for its implementation are discussed. (Author)

AD-761 758/CP PC A04/MF A01
Naval Postgraduate School Monterey Calif
An Investigation of the Computation of Upper Confidence Levels in a Series System
Master's thesis
Brent Dean Foster. Mar 73, 52p

Descriptors: *Reliability, *Statistical analysis, Confidence limits, Distribution functions, Random variables, Interpolation, Computer programs, Theses.
Identifiers: Sensitivity analysis, Bayesian estimation, Failure rate functions, Maximum likelihood estimation, N.

A comparison of several techniques is presented for determining upper confidence levels for a system failure rate. A series system of components with exponential failure rates is examined. Classical computational techniques are compared with Bayesian techniques in determining the upper confidence level of a system failure rate. A sensitivity analysis is conducted on several of the parameters as part of the comparison. (Author)

AD-762 003/CP PC A03/MF A01
California Univ Los Angeles Western Management Science Inst
An Interactive Program for the Job Shop Scheduling Problem with Due Dates
Charles A. Holloway, and Rosser T. Nelson. May 73, 28p Rept no. WMSI-Working Paper-199
Contract N00014-69-A-0200-4004
Prepared in cooperation with Stanford Univ., Calif. Graduate School of Business.

Descriptors: *Scheduling, Mathematical models, *Programming(Computers), Machine shop practice, Stochastic processes, Optimization.
Identifiers: *Job shop scheduling, Job scheduling, FORTRAN, N.

Interactive scheduling procedures for job shop problems are appealing because current scheduling techniques cannot deal with the problem in its full complexity. The report presents an interactive model which builds on a multi-pass heuristic scheduling procedure for the due-date problem. The program allows a human scheduler to interact to improve schedules and modify problem descriptions in an attempt to arrive at a satisfactory solution. A discussion of the model's capabilities and detailed operating procedures are contained in the report. (Author)

AD-762 015/CP PC A02/MF A01
Utah Univ Salt Lake City Computer Science Div
A Computer Graphics Method for Solving Transcendental Equations
Carl H. Durney. Dec 70, 17p Rept no. UTEC-CSc-70-109
Contract F30602-70-C-0300, ARPA Order-829

Descriptors: *Programming(Computers), Graphics, *Transcendental functions, Programming(Computers), Computer programs, Complex variables.
Identifiers: *Computer graphics, Roots of equations, AF.

Finding the roots of an equation F(x)=0 when F(x) involves transcendental functions and x is complex usually involves some kind of search method. The efficiency of a search method depends to a certain extent on knowledge of the roots--where they are likely to occur in the x plane, and how many there are. If a root is known to lie in a given region in the x plane, then a search routine can quickly find the root to the desired accuracy. But if no information about the location of the roots is available, a search over a wide area must be conducted, and this can be time consuming and expensive. Consequently, a method for locating the general area of the roots and determining the pattern of the roots is very valuable. The report describes a simple method for graphically displaying the pattern of roots in the complex plane. (Modified author abstract)

AD-762 419/CP PC A03/MF A01
Naval Research Lab Washington D C
FORTRAN Subroutines for Bicubic Spline Interpolation
Final memorandum rept.
John J. Cornyn. Jun 73, 47p Rept nos. NRL-MR-2596, NRL-Computer Bull-32

Descriptors: *Interpolation, *Computer programs, Approximation(Mathematics), Subroutines.
Identifiers: *Spline interpolation, FORTRAN, *Bicubic splines, CDC 3800 computers, N.

Two CDC 3800 FORTRAN subroutines (BICUB1 and BICUB2) which perform bicubic spline interpolation of a tabulated function of two variables are described. Given the values X(1),...,X(N) and Y(1),...,Y(M) of two independent variables and the corresponding function values U(I,J)=f(X(I), Y(J)), I=1,...,N and J=1,...,M and certain normal derivatives (optional) along the boundaries of the x-y mesh, BICUB1 estimates the derivatives f(x), f(y), and f(xy) at each (I,J) mesh point. If the normal derivatives along the mesh boundaries are unknown, BICUB1 estimates them using a moving third order two dimensional Lagrange interpolating polynomial. Given the coordinates (XPT, YPT) and the derivatives calculated by BICUB1, BICUB2 obtains the coefficients of the bicubic polynomial for the rectangular region of the mesh containing (XPT, YPT) and estimates the functional value UPT=f(XPT,YPT). In effect, the routines pass a twice continuously differentiable piecewise bicubic polynomial, u(x,y) belongs to (C sup 2), through the given functional values. (Author)

AD-762 722/CP PC A06/MF A01
Science Applications Inc La Jolla Calif
Techniques for Efficient Monte Carlo Simulation. Volume II. Random Number Generation for Selected Probability Distributions
Final rept.
E. J. McGrath, and D. C. Irving. Mar 73, 120p Rept no. SAI-72-590-LJ-Vol-2
Contract N00014-72-C-0293
See also Volume 1, AD-762 721 and Volume 3, AD-762 723.

Descriptors: *Monte Carlo method, Simulation, *Random variables, Sources, Computer programs, Efficiency, Statistical distributions.
Identifiers: *Random numbers, FORTRAN, Weibull density functions, Johnson density functions, Pearson density functions, Applications of mathematics, N.

Algorithms for efficient generation of random numbers from various probability distributions are presented, in both a flowchart form and as a sample FORTRAN subroutine. Twenty-two different distributions, including all commonly encountered discrete and continuous functions, the Weibull, Johnson, and Pearson families of empirical distributions, and histogram distributions, are covered. The general techniques to apply in deriving a random number selection scheme for an arbitrary distribution are discussed. A machine-independent subroutine for generating uniform random numbers is also described. (Author)

AD-763 206/CP PC A10/MF A01
White Sands Missile Range N Mex Instrumentation Directorate
Errors in Fractional Integer Programming
Final rept.
John C. Davies. Jun 73, 212p* Rept no. STEWS-ID-I-73-2

Descriptors: *Linear programming, Errors, Computer programs, Numerical analysis, Simplex method, Algorithms, Convergence, Matrix algebra.
Identifiers: *Integer programming, Matrix inversion, A.

The generation and propagation of numerical error in the fractional integer program was examined. The developments of error propagation in methods of matrix inversion were partially extended to both the continuous and discrete linear programs. It was shown that, because of the constraints imposed by the linear and integer programs on pivot selection, the strict upper bounds and characterization of error growth in matrix inversion did not apply. It was further shown that the rate of error growth in the integer linear program can be far

greater than that for the linear program in continuous variables. The effect of numerical error in decision variables on behavior of an algorithm to solve the fractional integer program was examined. Methods for monitoring and controlling the growth of numeric error in the integer program were examined. The interaction of a group of source-selection rules with a group of dual (entering variable) rules was examined.

AD-763 659/CP PC **A04**/MF **A01**
Naval Research Lab Washington D C Operations Research Branch
Algebraic Manipulation by Computer
Final rept.
R. R. Dasenbrock. 29 Jun 73, 71p Rept nos. NRL-7564, 73-1

Descriptors: *Programming(Computers), Algebra, Compilers, Computer programs, Polynomials, Differential equations, Series, Integration.
Identifiers: FORTRAN, CDC 3800 computers, Computation, Legendre functions, N.

The report describes a program which has the capability of performing literal algebraic manipulations on a high speed electronic computer. Emphasis is concentrated on the manipulation of the Poisson series occurring in the classical theory of lightly perturbed dynamical systems. The program is written in FORTRAN and is now operational on a CDC-3800. With little or no modification it could be implemented on any computer possessing a FORTRAN compiler. (Author)

AD-763 896/CP PC **A02**/MF **A01**
Ballistic Research Labs Aberdeen Proving Ground Md
Symbol Manipulation with Turan's Inequality for the Legendre Polynomials
Memorandum rept.
Walter O. Egerland, and George C. Francis. Jun 73, 18p Rept no. BRL-MR-2302

Descriptors: *Matrix algebra, Inequalities, Polynomials, Programming(Computers).
Identifiers: Legendre functions, SYMAP 2 computer program, FORTRAN, Convex functions, A.

SYMAP 2, an operational computer-based algebraic symbol manipulator developed at the Ballistic Research Laboratory, has been applied as a research tool. Its use in testing a conjecture on the convexity of Turan's determinant for the Legendre polynomials is described. An analytic proof of the conjecture and an application are also given. (Author)

AD-763 901/CP PC **E03**/MF **A01**
Army Weapons Command Rock Island Ill General Thomas J Rodman Lab
CRAMER: A FORMAC Algorithm for Exact Solution of Linear Equations with Parametric Coefficients
Final rept.
James E. Crosheck. Apr 73, 70p Rept no. R-RR-T-6-21-73

Descriptors: *Programming(Computers), Matrix algebra, Computer programs, Stochastic processes, Algorithms.
Identifiers: CRAMER computer program, FORMAC programming language, Markov chains, Computation, A.

A FORMAC (FORmula MAnipulation Compiler) program is documented and illustrative examples are given. The program is used to derive exact solutions of the matrix equation AX = B where A and B may depend on parameters (not on elements of X). A modification of Cramer's Rule is used to define the solution. Provision is made in the program to perform manipulative operations on the solution, if desired. A listing of the program is provided. (Author)

AD-764 014/CP PC **E01**/MF **A01**
Stanford Univ Calif Stanford Electronics Labs
Open, Closed, and Mixed Networks of Queues with Different Classes of Customers
Technical rept. no. 33
Richard R. Muntz, and Forest Baskett. Aug 72, 42 Rept nos. SU-SEL-73-016, STAN-CS-73-360
Contract N00014-67-A-0112-0044, DAHC15-69-C-0258

Descriptors: *Programming(Computers), *Queueing theory, Networks, Data processing systems, Scheduling, Integral transforms, Input-output devices, Mathematical models, Time sharing, Multiple operation.
Identifiers: Computer networks, Laplace transformation, *Multiprogramming, N.

The authors derived the equilibrium distribution of states of a model containing four different types of service centers and R different classes of customers. From this steady state distribution one can compute the moments of the queue sizes for different classes of customers at different service centers, the usage of the service centers, the 'cycle time' or response time for different classes of customers, the 'throughput' of different classes of customers, and other measures of system performance. The model allows different classes of customers to have different arrival rates and different routing probabilities. For open networks some very simple formulas give the marginal distribution of customers at the service centers of the network. Allowing different classes of customers should answer one of the principal objections to queueing models as models of computer systems. The example given indicates how significant different classes of customers can be in the safe levels predicted by model analysis. (Modified author abstract)

AD-764 084/CP PC **A02**/MF **A01**
Case Western Reserve Univ Cleveland Ohio Dept of Mathematics and Statistics
The Proportional Closeness and the Expected Sample Size of Sequential Procedures for Estimating Tail Probabilities in Exponential Distributions
Technical rept.
S. Zacks. 31 May 73, 23p Rept no. TR-14
Contract N00014-67-A-0404-0009

Descriptors: *Statistical distributions, *Sampling, Random variables, Probability density functions, Sequential analysis, Approximation(Mathematics), Reliability, Mathematical prediction, Computer programs.
Identifiers: *Exponential density functions, Maximum likelihood estimation, Normal density functions, Wiener processes, Gamma function, FORTRAN 4 programming language, FORTRAN, N.

The paper discusses the oroblem of exact determination of the proportional closeness probability and expected sample size of a sequential procedure for estimating tail probabilities in exponential distribution. The stopping variable is based on the asymptotic normality of the maximum likelihood estimator. For small and medium size samples an exact recursive procedure is derived. This procedure fails in large sample cases due to computer problems. For this reason large sample approximations are developed. These approximations are based on an analogous problem for Wiener processes. It provides very good numerical procedures. (Author)

AD-764 621/9CP PC **A04**/MF **A01**
Massachusetts Univ Amherst
A Chance Constrained Multiple Choice Programming Algorithm
Technical rept.
Ronald D. Armstrong, and Joseph L. Balintfy. Jun 73, 64p Rept no. TR-6
Contract N00014-67-A-0230-0006

Descriptors: *Mathematical programming, Stochastic processes, *Diet, Mathematical models, Linear programming, Nonlinear programming, Convex sets, Random variables, Food, Selection, Computer programs.
Identifiers: *Menu planning, Integer programming, N.

A multiple choice programming problem is considered where the elements of the activity matrix can be random variables or random vectors. The truncated block enumeration method of multiple choice programming is described and used in the development of the algorithm. Efficient use of inequalities computed from the means and variances affected by blockpivoting assures fast convergence to a (sub) optimal solution. The solution will satisfy each constraint with the required marginal probabilities, but the lower bound of the joint probabilities is also computed. As an option, problems can be solved when the lower bound of the joint probability that all the constraints are satisfied is specified alone. Sample solutions of an elementary stochastic menu problem illustrate the working of the options and the meaning of possible interpretations of chance constraints. (Author)

AD-764 737/3CP PC **E03**/MF **A01**
Maryland Univ College Park Computer Science Center
TSAP - A Time Series Analysis Package for Terminal Use
Robert R. Singers. Jan 73, 85p AFOSR-TR-73-1260
Grant AF-AFOSR-1982-71

Descriptors: *Time series analysis, Programming(Computers), Correlation techniques, Stochastic processes, Regression analysis.
Identifiers: TSAP computer program, UNIVAC 1108 computers, FORTRAN 5 programming language, FORTRAN, On line systems, Spectrum analysis, AF.

The time series analysis package, TSAP, is an on-line system of interactive, functionally dependent programs for the analysis of time series. This analysis usually consists of a long sequence of statistical computations which requires decision making as to the direction of the analysis interspersed within the computations. TSAP was designed for the UNIVAC 1108 computer in FORTRAN 5 with a few primitives in ASSEMBLER. The system performs data transformations and filtering, spectral analysis, and forecast modeling. (Author)

AD-765 331/4CP PC **A03**/MF **A01**
Yale Univ New Haven Conn Dept of Statistics
ASP: A Statistical Package in APL
Technical rept.
Francis J. Anscombe. Jul 73, 27p Rept no. TR-29
Contract N00014-67-A-0097-0014
Draft appendix to the forthcoming book, 'Statistical Computing with APL'.

Descriptors: *Statistical analysis, *Computer programs, Regression analysis, Programming languages, Syntax, Algorithms.
Identifiers: Contingency tables, APL programming language, N.

The report presents a collection of computer programs for statistical analysis of data, written in the programming language APL, for execution in IBM's interactive system APL/360. A short introduction comments on special features of computing for statistical analysis and suggests some precautions in the writing of such programs. This material is intended to appear eventually as an appendix to the author's forthcoming book, 'Statistical computing with APL'.

AD-765 720/8CP PC **A03**/MF **A01**
George Washington Univ Washington D C Inst for Management Science and Engineering
A Guide to a SUMT-Version 4 Computer Subroutine for Implementing Sensitivity Analysis in Nonlinear Programming
Robert L. Armacost, and W. Charles Mylander. 9 Jul 73, 28p Rept no. Serial-T-287
Contract N00014-67-A-0214-0001

Descriptors: *Nonlinear programming, Sensitivity, *Computer programs, Nonlinear programming, Algorithms, Approximation(Mathematics).
Identifiers: *Sensitivity analysis, SUMT 4 computer program, FORTRAN 4 programming language, FORTRAN, Parametric programming, N.

A computer program is presented which implements a procedure for conducting a sensitivity analysis of a nonlinear programming problem in conjunction with the sequential unconstrained

minimization technique for nonlinear programming. The algorithm used in the procedure is also presented. The method of incorporating the sensitivity analysis subroutines in the SUMT-Version 4 computer code is described. The user can direct the code to execute the sensitivity analysis procedure either along the minimizing trajectory or at the final subproblem. Annotated listings and flow charts of the subroutines are included. (Author)

AD-766 089/7CP PC A02/MF A01
HRB-Singer Inc State College Pa
Research on an OPTIMIZER Computer Program for Use in Simulation Studies
Final rept.
Dennis E. Smith, and C. Edward Storck. Aug 73, 21p Rept no. HRB-4352.11-F
Contract N00014-69-C-0285

Descriptors: *Problem solving, *Optimization, *Programming(Computers), Problem solving, Armed Forces operations, Decision making, Mathematical models, Simulation.
Identifiers: OPTIMIZER computer program, Computerized simulation, N.

The report summarizes a research effort which has resulted in development of a general-purpose computer program, OPTIMIZER, for aiding analysts assigned the task of obtaining improved simulation solutions. In view of evaluation results, there is strong evidence that analysts of varying levels of experience can profit from use of the complementary aid offered by the OPTIMIZER. The program promises to provide an analyst with the capability to augment his problem-solving procedures with new information and insights provided by statistically-based algorithms and to realize significant savings in valuable analysis time. (Author)

AD-766 492/3CP PC A03/MF A01
George Washington Univ Washington D C Dept of Statistics
Lower Confidence Limits for the Impact Probability Within a Circle in the Normal Case
Technical rept.
S. Zacks, and H. Solomon. 15 Aug 73, 28p Rept no. TR-9
Contract N00014-67-A-0214-0015

Descriptors: *Confidence limits, *Impact prediction, Probability density functions, Matrix algebra, Random variables, Computer programs.
Identifiers: FORTRAN, N.

Lower confidence limits are derived for the impact probability within a circle of fixed radius in the bivariate normal case with zero mean vector. For independent coordinates and known ratio of variances, the lower confidence limit is a strongly consistent estimator of the impact probability and is uniformly most accurate (UMA). When the ratio of the variances is also unknown, the lower confidence limit is a strongly consistent estimator of the impact probability. Some discussion is provided when the correlation between the coordinates is unknown. A Table of the impact probability function is provided which can be employed for both point estimation and for obtaining lower confidence limits and the use of the table is demonstrated. A FORTRAN program for the computation of the impact probability is included. (Author)

AD-766 882/5CP PC E04/MF A01
Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering
Robust Estimation of Location and Scale Parameters
Master's thesis
Loren W. Jorgenson. Jun 73, 98p Rept no. GSA/MATH/73-2

Descriptors: *Statistical distributions, Monte Carlo method, Sampling, Exponential functions, Population(Mathematics), Efficiency, Graphics, Theses, Computer programs, Mathematical prediction.
Identifiers: Estimation theory, Robust procedures, Parameter estimation, Maximum likelihood estimation, Exponential density functions, Normal density functions, Kurtosis, AF.

A Monte Carlo analysis was performed to determine the efficiency of the Harter robust estimators of the scale and location parameters of double exponential, normal, and uniform distributions relative to the maximum-likelihood estimators. Two modifications were made to the Harter estimators which increased the relative efficiency except when the underlying population was uniformly distributed. The modified estimators were then designated the Moore estimators and the Jorgenson estimators. Tables were prepared comparing the relative efficiencies of the Harter, Jorgenson, Moore, Hogg, Hodges-Lehmann, and the Switzer robust estimators of the location parameter for the double exponential, the normal, and the uniform distributions for samples of size 12 and 24. Two types of figure of merit were defined for a robust estimator. The choice of the best robust estimator is a function of sample size and the criteria used. (Author)

AD-767 375/9CP PC A03/MF A01
Yale Univ New Haven Conn Dept of Administrative Sciences
Discrete Variate Generation
Technical rept.
George S. Fishman. Sep 73, 36p Rept no. TR-28-4
Contract N00014-67-A-0097-0028

Descriptors: *Statistical distributions, *Programming(Computers), Digital computers, Transformations, Approximation(Mathematics), Compilers, Random variables.
Identifiers: Computerized simulation, *Binomial density functions, SIMSCRIPT 2 programming language, Computation, IBM 370/155 computers, Multiprogramming, N.

The paper examines alternative techniques for generating random variables from the Poisson, geometric, negative binomial and binomial distributions on a digital computer. A fourfold criterion is used to evaluate these techniques. The criterion is based on the CPU time needed to generate a variate, the sensitivity of this time to changing parameter values, numerical roundoff error and extent to which cost-saving distributional approximations can be used. One conclusion of the study is that in many cases the inverse transformation method appears more attractive than alternative techniques specific to particular distributions. (Author)

AD-767 604/2CP PC A08/MF A01
Georgia Univ Athens Dept of Statistics and Computer Science
An Interactive Analysis of Covariance Unit
Technical rept.
Mary E. Nash, and Rolf E. Bargmann. Jul 73, 169p Rept nos. TR-95, THEMIS-UGA-25
Contract N00014-69-A-0423

Descriptors: *Programming(Computers), *Analysis of variance, Computer programs, Regression analysis, Statistical analysis, Instruction manuals.
Identifiers: IBM 360/65 computers, *Covariance, Themis project, Computer graphics, FORTRAN, N.

The report contains description and program documentations of a conversational unit for analysis of covariance of data in regular or irregular two-way classification designs. The main part of this report on the basis of detailed illustrations. It describes the question-and-answer frames on a Graphics (IBM 2250) console. The user need not be familiar with programming or with computational details of analysis of covariance. He receives instructions for description of his data from graphically displayed questions. First, an analysis of variance is performed on the response variable. Means, adjusted means, and the analysis of variance table are reported. The user may edit data or see the data plotted before continuing the analysis. After the analysis of covariance, means and adjusted means of the response residuals are reported. The error matrix, correlations matrix, partial regression coefficients, and the analysis of covariance table are displayed. Again, the user may edit data or see plots (now including a regression line or curve). He may perform a new analysis of covariance for various subsets of the concomitant variables. Listings of the FORTRAN programs are contained in the appendix. (Author)

AD-767 643/0CP PC A04/MF A01
Naval Research Lab Washington D C
The Theory and Construction of Multivariate Gaussian Surfaces
Final rept.
Luise S. Schuetz, and George G. Zipfel, Jr. 31 Aug 73, 58p Rept no. NRL-7588

Descriptors: *Multivariate analysis, Surfaces, Stochastic processes, Fourier analysis, Confidence limits, Probability density functions, Correlation techniques, Computer programs, Milling machines.
Identifiers: Fast Fourier transform, Fourier transformation, RANMILL computer code, CDC 3800 computers, *Numerical control, N.

A procedure has been developed for the construction of random rough surfaces with statistics which approximate the ideal of multivariate Gaussian statistics with a prescribed spectrum. Estimates of the deviation of the sample surfaces from the ideal ensemble statistics are made. The procedure uses a fast-Fourier-transform algorithm to produce a numerical surface which is then used to construct a physical realization of the surface via a numerically controlled milling machine. The resulting surface is one which can be used in scattering experiments, and the degree of conformity of its statistics to those of the ideal is well understood. The use of these surfaces will eliminate a major source of uncertainty in the interpretation of controlled experiments. (Author)

AD-767 655/4CP PC E04/MF A01
Naval Postgraduate School Monterey Calif
The Generation of Gamma Distributed Variates and an Investigation of a Trend Test for the Gamma Renewal Process
Master's thesis
David Walter Robinson. Jun 73, 104p

Descriptors: *Statistical processes, Analysis of variance, Distribution functions, Random variables, Statistical tests, Computer programs, Compilers, Theses.
Identifiers: Renewal processes, Normal density functions, FORTRAN, FORTRAN 4 programming language, Computerized simulation, N.

In testing the hypothesis that there is no monotone trend in a gamma renewal process, the use of the statistic Y(J) = Y(2J)/Y(1J), where Y(1J) = the summation from i=1 to J of X(i) and Y(2J) = the summation from i=1 to J of S(i), is investigated. The mean and variance of Y(J) is developed as a function of J and it is shown that Y(J) is asymptotically normal as J approaches infinity for the gamma renewal process. A high-speed, theoretically exact gamma pseudo-random variate generator is developed, tested and compared with other known techniques. The generator is then used to obtain the distribution of Y(J) through digital computer simulation for small and moderate values of J. (Author)

AD-767 658/8CP PC A03/MF A01
Naval Postgraduate School Monterey Calif
A Branch and Bound Algorithm for the Delivery Truck Problem
Master's thesis
Stephen John Balut. Jun 73, 44p

Descriptors: *Scheduling, Algorithms, Transportation, Fuel consumption, Mathematical models, Optimization, Theses, Computer programs.
Identifiers: Branch and bound method, Routing, Delivery, Delivery problem, Transportation models, N.

The delivery truck problem is one in which a truck is loaded with m packages, one package to be delivered to each of m destinations. The amount of fuel consumed by the truck is directly dependent upon the current total weight of the truck, which includes both the weight of the packages and the amount of fuel remaining in the tank. The problem is to determine a sequence in which to deliver all m packages which will minimize total fuel consumption. A branch and bound algorithm for obtaining optimal solutions to the delivery truck problem is presented, along with several sample problems with their solutions. A brief report of computational experience is included. (Author)

AD-767 970/7CP PC **A04**/MF **A01**
Stanford Univ Calif Dept of Computer Science
Nonlinear Spline Functions
Michael A. Malcolm. Jun 73, 66p Rept no. STAN-CS-73-372
Contract N00014-67-A-0112-0029, Grant NSF-GJ-29988X

Descriptors: *Interpolation, Functions, Calculus of variations, Difference equations, Transcendental functions, Matrix algebra, Computer programs, Strain(Mechanics), Elasticity.
Identifiers: *Spline functions, *Spline interpolation, *Nonlinear spline functions, FORTRAN, Finite difference theory, N.

A mathematical characterization of nonlinear interpolating spline curves is developed through a variational calculus approach, based on the Euler-Bernoulli large-deflection theory for the bending of thin beams or elastica. Algorithms previously used for computing discrete approximations of nonlinear interpolating splines are discussed and compared. The discrete natural cubic interpolating spline is discussed. An algorithm for computing discrete natural cubic splines is given and analyzed for discretization error and computational difficulty. Finally, a new algorithm together with its FORTRAN implementation is given for computing discrete nonlinear spline functions. (Author)

AD-768 147/1CP PC **E04**/MF **A01**
Army Materiel Command Texarkana Tex Intern Training Center
An Introduction to Price-Adjusted Single Sampling with Quadratic Indifference
John Albert Jacobi, and Joseph W. Foster. Jul 71, 105p Rept no. USAMC-ITC-2-71-18

Descriptors: *Quality control, *Sampling, Acceptability, Tolerances(Mechanics), Curve fitting, Graphics, Computer programs.
Identifiers: Price adjustments, Indifference curves, Verification inspection, A.

The research introduces and develops the concept of price-adjusted sampling with quadratic indifference. The basic purpose of price-adjusted sampling is the elimination of the process of rejecting lots, a procedure practiced in the application of conventional acceptance sampling methods. A discussion and history of various sampling techniques is presented with an emphasis on the comparison of the qualities of linear and quadratic indifference. Techniques for arriving at higher order indifference curves are explained along with the economic implications of various types of curves. In order to fully document the behavior of any given plan, it is necessary to tullize a digital computer with plotting capability to illustrate the plan graphically. As a result, the application of the digital computer is emphasized heavily. (Author)

AD-768 154/7CP PC **A04**/MF **A01**
Army Tank-Automotive Command Warren Mich
Evaluation of Accuracy of Median Ranks and Mean Ranks Plotting for Reliability Estimation Using the Weibull Distribution
Technical rept.
Salvatore B. Catalano. Jun 73, 73p Rept no. TACOM-TR-11808

Descriptors: *Reliability, *Statistical analysis, Probability density functions, Monte Carlo method, Computer programs, Curve fitting, Graphics.
Identifiers: *Weibull density functions, Median(Statistics), Mean, Parameter estimation, A.

Estimates of the Weibull distribution parameters were made employing the mean ranks estimator; the estimates were repeated using the median ranks estimator. These estimates were compared to known values of the Weibull distribution parameters. This made it possible to compare the results obtained using either estimator (mean ranks or median ranks) and to determine the relative merits of using either estimator. The study made use of a digital computer and employed Monte-Carlo techniques to simulate Weibull distributed failure times. These failure times may represent tank-automotive component failures. (Author)

AD-769 624/8CP PC **A02**/MF **A01**
Texas Univ Austin Center for Cybernetic Studies
Past, Present and Future of Development, Computational Efficiency, and Practical Use of Large Scale Transportation and Transhipment Computer Codes
Research rept.
A. Charnes, Fred Glover, David Karney, D. Klingman, and Joel Stutz. Jul 73, 22p Rept no. CS-131
Contract N00014-67-A-0126-0008, N00014-67-A-0126-0009
Prepared in cooperation with Colorado Univ., Boulder.

Descriptors: *Transportation, Mathematical models, *Computer programming, Computations, Linear programming, Algorithms, Forecasting.
Identifiers: Transportation models, N.

Three generations of computers have elapsed since the first satisfactory method for solving transportation and transhipment problems was devised. During this time many computational advances have taken place in developing computer codes to solve these problems. The primary purpose of the paper is to summarize these events and to do some crystal ball gazing to provide what we believe to be best estimates of future trends. (Author)

AD-769 649/5CP PC **A04**/MF **A01**
Naval Underwater Systems Center New London Conn New London Lab
FORTRAN Programs for Non-Parametric Studies
Technical document
Richard L. Mason. 5 Oct 73, 54p Rept no. NUSC-TD-4597

Descriptors: *Statistical tests, *Computer programs, Sampling, Analysis of variance, Correlation techniques, FORTRAN.
Identifiers: *Nonparametric statistics, N.

FORTRAN programs (written as subroutines) are given to perform statistical tests which are not based on any particular underlying distribution for the data. The data are entered from a calling program, and the subroutine returns either the significance level for the tests or a correlation coefficient and its significance. Tests include the runs test for randomness of data, six hypothesis tests, the sign test, the Wilcoxon matched-pairs signed-ranks test, the Friedman two-way analysis of variance, the Kolmogorov-Smirnov two-sample test, the Kruskal-Wallis one-way analysis of variance, and two correlation tests, the Spearman rank correlation and the Kendall coefficient of concordance. Examples are given for the use of all tests. (Author)

AD-769 677/6CP PC **A03**/MF **A01**
Texas Univ Austin Center for Cybernetic Studies
Implementation and Computational Comparisons of Primal, Dual and Primal-Dual Computer Codes for Minimum Cost Network Flow Problems
Research rept.
F. Glover, D. Karney, and D. Klingman. Jul 73, 38p Rept no. CS-136
Contract N00014-67-A-0126-0008, N00014-67-A-0126-0009

Descriptors: *Network flows, Algorithms, Linear programming, Simplex method, Transportation, Mathematical models, Computer programming, Computations, FORTRAN.
Identifiers: Transportation models, Duality theory, Out of kilter algorithm, N.

The paper presents extensive computational experience with a special purpose primal simplex algorithm. The performance is compared to that of several 'state of the art' out-of-kilter computer codes. The computational characteristics of several different primal feasible start procedures and pivot selection strategies are also examined. The study discloses the advantages, in both computation time and memory requirements, of the primal approach over the out-of-kilter method. The test environment has the following distinguishing properties: (1) all of the codes are tested on the same machine and the same problems, (2) the test set includes capacitated and uncapacitated transhipment networks, transportation problems, and assignment problems, and (3) problem sizes ranging from 100 to 8,000 nodes with up to 35,000 arcs are examined. (Author)

AD-769 678/4CP PC **A02**/MF **A01**
Texas Univ Austin Center for Cybernetic Studies
Graphical Estimation for the Three-Parameter Lognormal Distribution
Research rept.
E. L. Frome. Sep 73, 17p Rept no. CS-139
Contract N00014-67-A-0126-0009

Descriptors: *Statistical distribution, Mathematical prediction, Probability density functions, Computer programs, FORTRAN, Algorithms.
Identifiers: Parameter estimation, Lognormal density functions, N.

The report describes an algorithm for the estimation of the parameters in the three-parameter lognormal distribution. The computational procedure is based on Wise's inflection triangle method, and is coded in ANSI Standard FORTRAN. An application to the real time analysis of human dye-dilution curves is discussed and an illustrative example is presented. (Author)

AD-769 801/2CP PC **E07**/MF **A01**
Naval Postgraduate School Monterey Calif
Minimizing the Cost of Projects in Naval Shipyards
Doctoral thesis
Norman John Shackelton, Jr. Sep 73, 177p

Descriptors: *Shipyards, Cost effectiveness, *Job, *Scheduling, Management planning and control, Manpower, Costs, Nonlinear programming, Linear programming, Dynamic programming, Quadratic programming, Allocations, Network flows, Theses, Computer programs, Navy.
Identifiers: Integer programming, Resource allocation, N.

The thesis is concerned with a problem of scheduling that arises in naval shipyards as well as in many other organizations. The problem considered is that of minimizing the total cost of a project with limited manpower available from the various shops and where the number of mandays to accomplish each activity in the project is specified. Total project cost consists of normal direct labor cost, overtime cost, and a penalty for exceeding some specified target date. It is shown that this problem includes several other, more common scheduling problems such as job-shop scheduling. The relationship among the various problems is described including the use of existing solution procedures to solve special cases of the shipyard problem. (Modified author abstract)

AD-769 971/3CP PC **E07**/MF **A01**
Michigan Univ Ann Arbor Coll of Engineering
Operator Approximation and Its Application to Root Finding and Minimization Problem
Technical rept.
G. Scott Dixon, Jr. Jun 73, 180p 026450-3-T, AFOSR-TR-73-2000
Grant AF-AFOSR-1767-69

Descriptors: *Functions(Mathematics), *Computations, Approximation, Transformations(Mathematics), Operators(Mathematics), Matrices(Mathematics), Computer programs, Theorems, Optimization.
Identifiers: Roots of equations, AF.

The report is concerned with two closely related computational problems: the determination of the unconstrained minimum of a scalar function of n variables, the determination of a zero of an n-vector function of n variables. A variety of methods for approximating nonlinear operators by numerically evaluating the operator is considered. This basic approach leads to a unified derivation of many known conjugate direction algorithms for function minimization. New algorithms are also derived. Particular attention is given to a 'secant-like' class of algrotihms for function minimization. (Modified author abstract)

AD-770 256/6CP Not available NTIS
Office of the Assistant for Study Support Kirtland AFB N Mex
Cluster Analysis for Applications
Michael R. Anderberg. 1973, 372p Rept no. OAS-TR-73-9
Supersedes report dated Jan 72, AD-736 301.
Availability: Paper copy available from Academic Press Inc., 111 Fifth Ave., 1003 New York, N. Y. $25.00.

Descriptors: *Statistical analysis, *Applied mathematics, Classification, Correlation techniques, Matrices(Mathematics), Measure theory, Computer programs, Textbooks.
Identifiers: *Cluster analysis, Clumps, AF.

Cluster analysis is a collective term covering a wide variety of techniques for delineating natural groups or clusters in data sets. This book integrates the necessary elements of data analysis, cluster analysis, and computer implementation to cover the complete sequence of steps from raw data to the finished analysis. The author develops a conceptual and philosophical basis for using cluster analysis as a tool of discovery and applies it systematically throughout the book. He provides a comprehensive discussion of variables, scales, and measures of association that establishes a sound basis for constructing an operational definition of similarity tailored to the needs of any particular operational definition of similarity tailored to the needs of any particular problem, and devotes special attention to the problems of analyzing data sets containing mixtures of nominal, ordinal, and interval variables. (Author)

AD-770 563/5CP PC **A08**/MF **A01**
Air Force Armament Lab Eglin AFB Fla
Constrained Multidimensional Minimization without Derivatives. Some Variants of Powell's Method
Final rept. Oct 72-Apr 73
James V. Blowers. Jul 73, 168p Rept no. AFATL-TR-73-149

Descriptors: *Mathematical programming, *Computer programs, *Functions(Mathematics), Algorithms, Optimization.
Identifiers: Powell method, Constraits, AF.

The report discusses two computer versions of Powell's method for minimizing an arbitrary function of several variables with interval constraints without using derivatives. For each code a descriptive algorithm, a list of variables, and several examples are given. The two codes are then extended to cover linear constraints in three ways. All of these include adjusting the penalty functions to fit the linear constraints. In addition to this, the second technique orients the reference directions parallel to the constraints and the third technique projects the successive directions generated by Powell's method onto the constraints during the execution of the body of the algorithm. The third method is thus a hybrid of Powell's method and Rosen's gradient projection method. All of these methods are fast, and none requires derivatives. When these three methods are applied to the two original routines, the result is six new routines. These are applied to an example related to probability of kill problems with varying degrees of success. Again, descriptive algorithms and lists of variables are given. (Author)

AD-770 715/1CP PC **A04**/MF **A01**
Wisconsin Univ Madison Mathematics Research Center
Package for Calculating with B-Splines
Technical summary rept.
Carl de Boor. Oct 73, 57p Rept no. MRC-TSR-1333
Contract DA-31-124-ARO(D)-462

Descriptors: *Approximation, *Interpolation, *Computer programs, Computations, FORTRAN, Polynomials, Subroutines, Theorems.
Identifiers: *Spline functions, Spline interpolation, Collocation(Mathematics), A.

Eight FORTRAN subprograms for dealing computationally with piecewise polynomial functions (of one variable) are presented. The package is built around an algorithm for the stable evaluation of B-splines of arbitrary order and with knots of arbitrary multiplicity. Four examples illustrate how one might use these routines: interpolation by splines of general order k (and not necessarily at the knots); least squares approximation by splines to discrete data; the determination of the derivative of a spline with respect to a knot; and the approximate solution of an ordinary differential equation with rather general side conditions by collocation. (Author)

AD-770 997/5CP PC **A06**/MF **A01**
Massachusetts Inst of Tech Lexington Lincoln Lab
Nonstationary Spectral Analysis for Linear Dynamic Systems
Technical rept.
William R. Davis, Jr. 31 May 73, 117p TR-504, ESD-TR-73-166
Contract F19628-73-C-0002

Descriptors: *Spectrum analysis, *Statistical processes, *Signal processing, Fourier transformation, Time series analysis, Signal processing, Computer programs, Ground motion, Earthquakes, Pyrotechnics, Shock waves, Mathematical models, Linear systems, Computer programs, FORTRAN, Theses.
Identifiers: *Order statistics, *Nonstationary processes, Fast Fourier transorm, AF.

Advantages of using time dependent spectra over other representations of second-order statistics of nonstationary processes are studied with emphasis on 'instantaneous' and evolutionary spectral densities. An integrated procedure for the time dependent spectral response calculation for linear systems with digital analysis of input data is presented for excitation processes which are formed from the product of deterministic envelopes and stationary random processes. Linear response is approximated using finite sum Fourier series for the input envelope, the Fourier coefficients being estimated directly from input time records. Bounds on the spectral density of the underlying stationary excitation process are calculated using discrete Fourier transform techniques which take advantage of the fast Fourier transform algorithm. Both the data analysis and linear response relations offer advantages over previous methods in simplicity and computational effort. Examples using pyrotechnic shock time histories and artificial earthquake motions illustrate the procedure. (Author)

AD-771 068/4CP PC **A03**/MF **A01**
Grumman Aerospace Corp Bethpage N Y Research Dept
On a Numerical Scheme for Solving Nonlinear Boundary Value Problems with Mixed Boundary Conditions
Research memo.
Reuben R. Chow. Nov 73, 29p Rept no. RM-582

Descriptors: *Numerical integration, *Partial differential equations, *Nonlinear differential equations, *Fluid flow, Numerical methods and procedures, Matrices(Mathematics), Computer programs, FORTRAN.
Identifiers: FORTRAN 4 programming language, Parabolic differential equations, SD.

In the paper, the author develops a modification of Keller's box scheme for solving boundary value problems to cover cases with mixed boundary conditions. Keller's scheme is a very efficient finite difference algrotihm for solving systems of ordinary differential equations and systems of parabolic partial differential equations. The original method employed a block tridiagonal matrix formulation that was not directly applicable to problems with mixed boundary conditions. The author applied the present generalized method to the solution of two boundary value problems that arise in the theory of laminar viscous interactions. The main program is used as the core in a number of other computer codes to solve a variety of viscous problems. A user-oriented FORTRAN 4 subroutine is also included for the solution of the present matrix system. (Author)

AD-772 091/5CP PC **A02**/MF **A01**
Naval Weapons Lab Dahlgren Va
Interpolations of Surface Wave Trains
Technical rept.
A. V. Hershey. Nov 73, 25p Rept no. NWL-TR-3064

Descriptors: *Surface waves, *Computer programming, *Interpolation, Approximation, Numerical integration, Computer programs, FORTRAN, Matrices(Mathematics).
Identifiers: Wave trains, CDC 6700 computers, CDC 6400 computers, N.

There are two FORTRAN subroutines for computing the components of velocity in the wave train of a point source. They differ in the method of approximation. Changing the method from Taylor series expansion to Lagrange interpolation gave a seven-fold increase in efficiency. Three-dimensional interpolation in a table of data would not be more economical. (Author)

AD-772 123/6CP PC **A04**/MF **A01**
Georgia Univ Athens Dept of Statistics and Computer Science
A Conversational Unit for Spline Function Construction
Technical rept.
Janice Stevens Scott, and James E. Norman, Jr. Aug 72, 74p Rept nos. TR-91, THEMIS-UGA-24
Contract N00014-69-A-0423

Descriptors: *Splines, *Interpolation, *Curve fitting, *Computer programs, Matrices(Mathematics), Graphics.
Identifiers: *Spline functions, SPLINE computer program, N.

The report describes an interactive computer program which enables the user to fit a third degree spline function to a set of n points (x sub i, y sub i), 3n 50 where the x sub i's are distinct. Point ordinates can be changed and the resulting modified spline fitted. The equation of the spline function is provided for interpolation purposes. (Author)

AD-772 861/1CP PC **E05**/MF **A01**
Naval Postgraduate School Monterey Calif
A Study of Deterministic Survivable Networks
Master's thesis
Ruben F. Labre. Dec 73, 94p

Descriptors: *Network flows, *Graphics, Topology, Set theory, Computer programs, Algorithms, Theses.
Identifiers: *Graph theory, Network analysis theory, Network synthesis, N.

The idea of survivability introduced as a network parameter has led to so many investigations. Several measures of survivability has been studied. The number of links and/or stations needed to be damaged to disrupt the system is the survivability criterion adapted in the study. The development of analysis procedures for directed, undirected, or mixed networks based on the above criterion and use of the concepts in network flow and graph theory are treated in detail including computer program implementation of the algorithms. Finally a practical design algorithm for minimum-cost survivable network with respect to branch disconnection using a heuristic approach and analysis techniques is described. (Author)

AD-773 037/7CP PC **E05**/MF **A01**
Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering
Goal Programming
Master's thesis
Ronald J. Marini. Dec 73, 98p Rept no. GSM/SM/73-18

Descriptors: *Linear programming, Functions(Mathematics), Optimization, Decision theory, Management, Simplex method, Computer programs, Theses
Identifiers: *Goal programming, Constraints, AF.

A tutorial development of goal programming is presented. Special emphasis is placed on model formulation and the nature of the weighting factors in the objective function. Several solution techniques are discussed and a method for using a conven-

tional linear programming computer solution package for goal programming is presented. (Author)

AD-773 190/4CP PC E03/MF A01
Technology Inc Dayton Ohio
The Schwarz Normal Form of a Matrix and its Application to Flutter Stability Problems (Ein Verfahren zur Stabilitatsfrage bei Matrizen-Eigenwert Problem)
Hans-Rudolf Schwarz. Nov 73, 49p ARL-73-0166
Contract F33615-71-C-1463
Trans. of Zeitschrift fuer Angewandte Mathematik und Physik (Switzerland) v7 n473-500 1956, by Henry E. Fettis.

Descriptors: *Flutter, *Matrices(Mathematics), Eigenvectors, Transformations(Mathematics), Polynomials, Continued fractions, Computer programs, FORTRAN, Translations, Switzerland.
Identifiers: Canonical forms, Eigenvalues, AF.

Given the Eigenvalue problem (A - lambda E)x = 0 for a real or complex matrix A, the number of Eigenvalues lambda with positive real parts is determined without evaluating the characteristic polynomial. A procedure is developed to transform the given matrix A to a canonical form by means of a finite series of elementary transformations of the matrix. The elements of the reduced matrix allow one to solve immediately the stability problem. (Author)

AD-773 454/4CP PC E07/MF A01
Georgia Univ Athens Dept of Statistics and Computer Science
Table of the Cumulative Standardized Pearson Type 4 Distribution Function
Technical rept.
Hubert Bouver. Dec 73, 178 Rept nos. TR-100, THEMIS-UGA-28
Contract N00014-69-A-0423

Descriptors: *Distribution functions, *Distribution theory, *Curve fitting, Computer programs, Tables(Data), Probability density functions.
Identifiers: *Pearson type 4 density functions, Themis project, N.

The report presents the derivation of formulas, a curve fitting example, development and documentation of computer programs of the Pearson Type 4 distribution function. The computer subprogram function TYPE4X evaluates the cumulative distribution function, TYPEP is the inverse function of TYPE4X and TYPE4Z evaluates the probability density function. (Author)

AD-773 787/7CP PC A05/MF A01
TRW Systems Group Mclean Va Washington Operations
A Method for Incorporating Time-Preference Judgements in Weapon Systems Studies
Final rept.
D. Schwartz, and D. Goldstein. 30 Nov 72, 87p
Rept no. 17531-W002-RO-0239
Contract N00014-71-C-0239
See also report AD-742 855.

Descriptors: *Military personnel, *Decision theory, *Weapon systems, Allocations, Cost effectiveness, Computer programs, Time sharing, Time series analysis.
Identifiers: *Utility theory, Automata theory, Resource allocation, Benefit cost analysis, N.

The objective of the research was to develop a methodology based on elements of decision theory and utility theory which will permit discounting of future benefits and cost streams to determine present value of time phased resource allocation options. Additionally, the methodology was to be applicable, a posteriori, to previous analyses to determine what combinations of discount rates and utility functions are consistent with previous study recommendations. The objective was achieved on both accounts. A formal mathematical development of the concepts necessary for the decision maker to analyze and choose from a list of alternative courses is presented in the text. Interpretation and implications of the concepts are then developed for the reader. An algorithm for applying the technique is likewise developed, both for looking at past actions and for making new decisions. A special application of automata theory is developed to assist in making new decisions. A claim is made that the approach is simple and direct and, when applied to complicated decisions, avoids the possibility of error inherent in other techniques. (Author)

AD-773 796/8CP PC E04/MF A01
Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering
An Explanation and Comparison of the Zero-One Integer Programming Algorithms of Bush, Balas, and Healy as Used on a Particular Resource Allocation Problem
Master's thesis
Nicholas Richard Duva. Nov 73, 92p Rept no. GSM/SM/73-8

Descriptors: *Mathematical programming, Algorithms, Linear programming, Simplex method, Computer programs, Allocations, Theses.
Identifiers: Resource allocation, Zero one programming, *Integer programming, AF.

Problem manipulation has been defined as the restatement of a mathematical programming problem in an alternative, but essentially equivalent form, more amenable to solution than the original. Richard L. Bush was interested in a particular type of problem manipulation which resulted in an equivalent knapsack problem form for a mathematical programming problem. Stanley Zionts' modification of Balas' method of implicit enumeration minimizes zero-one integer programming problems with 'less than or equal to' constraints. The Healy algorithm is applicable where variables must be either or one, and the variables are divided into integer sets such that the variables in each set sum to unity. The author presents a detailed explanation and comparison of these algorithms as used on a particular resource allocation problem. (Modified author abstract)

AD-773 921/2CP PC A03/MF A01
Georgia Univ Athens Dept of Statistics and Computer Science
On the Numerical Approximation of One, Two and Three Dimensional Integrals
Technical rept.
Hubert S. Bouver, and Frank G. Lether. Nov 72, 47p Rept nos. TR-98, THEMIS-UGA-26
Contract N00014-69-A-0423

Descriptors: *Integrals, *Approximation, *Computer programs, Numerical integration, FORTRAN.
Identifiers: FORTRAN 4 programming language, CDC 6400 computers, N.

The purpose of this technical report is to present an elementary technique for the approximation of one, two and three dimensional integrals. Numerical examples are given which employ the numerical integration technique discussed in the report along with the listing of all programs in FORTRAN 4. (Author)

AD-774 040/0CP PC A02/MF A01
Texas Univ Austin Center for Cybernetic Studies
Cross-Spectrum Smoothing Via the Finite Fourier Transform
Research rept.
Edward L. Frome. Jan 74, 16p Rept no. CS-164
Contract N00014-67-A-0126-0008

Descriptors: *Time series analysis, *Fourier transformation, Spectrum analysis, Estimates, Computer programs, FORTRAN.
Identifiers: Fast Fourier transform, Smoothing(Mathematics), Bivariate analysis, N.

An algorithm is presented that computes estimates of the spectra and cross-spectrum from a realization of a bivariate time. The spectral estimates are computed by averaging the periodogram over neighboring frequencies, and the algorithm is coded in ANSI Standard FORTRAN. (Author)

AD-774 133/3CP PC A05/MF A01
George Washington Univ Washington D C Inst for Management Science and Engineering
Some Simple Bounds and Approximations in Queueing
William George Marchal. 9 Jan 74, 81p Rept no. Serial-T-294
Contract N00014-67-A-0214-0001

Descriptors: *Queueing theory, *Approximation, Random variables, Distribution functions, Theorems, FORTRAN, Computer programs.
Identifiers: *GI/G/1 queue, Service time, GI/G/c queue, N.

The paper surveys the current state of the art of finding bounds and approximations in queueing theory. It then proceeds to offer a new lower bound on the limiting expectation of the line wait for the GI/G/1 case and follows through with the implications of this lower bound for the multiserver case and for the case of tandem queues. The effect on waiting times of priority disciplines is also discussed. Secondly, the study turns to an approximation for the mean wait in queue which is a function solely of the first two moments of the interarrival and service-time distributions. The approximation is shown to be exact in the case of exponential interarrivals and to perform well in other situations. Finally, a novel method of approximating the GI/G/1 queue by a modified E sub k/E sub l/1 queue is presented. The presentation includes both the theory of the method and detailed listings of the algorithms to facilitate their use on computers with FORTRAN compilers. (Author)

AD-774 197/8CP PC A03/MF A01
Wisconsin Univ Madison Mathematics Research Center
User's Instructions for the Integer Programming Coed ENUMER8
Technical summary rept.
L. E. Trotter, Jr. Dec 73, 40p Rept no. MRC-TSR-1347
Contract DA-31-124-ARO(D)-462

Descriptors: *Mathematical programming, *Computer programs, Instruction manuals.
Identifiers: *Interger programming, ENUMER8 computer program, Implicit enumeration, A.

User's instructions and a program listing are given for the program ENUMER8 which solves bounded variable pure integer programming problems by implicit enumeration. Computer input and output listings for a sample problem are also included. (Author)

AD-774 403/0CP PC A02/MF A01
Air Force Cambridge Research Labs L G Hanscom Field Mass
Least Squares Cubic Splines
Physical sciences research papers
Victor L. Corbin, and Antonio F. Quesada. 29 Oct 73, 23p Rept nos. AFCRL-PSRP-572, AFCRL-TR-73-0661

Descriptors: *Least squares method, *Splines, Partial differential equations, Curve fitting, Approximation, Computer programs.
Identifiers: Cubic spline technique, Spline approximation, AF.

An important feature of ordinary cubic splines results from the conditions of continuity of the function and its first two derivatives that are improved at each data point. Consequently, this method is not useful with experimental data, which is the sum of the true value of a function and some random noise. The authors have combined the least squares criteria with the spline conditions to obtain a set of equations which allow one to perform least squares curve fitting with cubic splines. (Author)

AD-774 767/8CP PC A07/MF A01
Massachusetts Inst of Tech Cambridge Project Mac
MACSYMA Reference Manual. Version 6
Richard A. Bogen. Jan 74, 144p
Contract N00014-70-A-0362-0006
Second printing of Version 6 of Project MAC's SYmbolic MAnipulation System (MACSYMA).

Descriptors: *Computer programming, *Instruction manuals, Mathematical analysis.

Identifiers: MAC project, MACSYMA computer program, LISP programming language, PDP-10 computers, *Programming manuals, N.

MACSYMA (Project MAC's SYmbolic MAnipulation System) is a large computer program developed by the Mathlab group of Project MAC's Automatic Programming Division. It is written in LISP (Mn1) and runs under the ITS time sharing system (Ea1) on a DEC PDP-10 computer at Project MAC, MIT. MACSYMA has capabilities for manipulating algebraic expressions involving numbers, variables, and functions. It can differentiate, integrate, take limits, solve equations, factor polynomials, expand functions in power series, plot curves, etc. In addition there are facilities for manipulating lists, subscripted variables, equations, and matrices with many of the usual operations on them being available. The user can also create his own functions and he can extend existing functions and operators. This manual is intended to be a complete reference to the principal features of MACSYMA as of the date shown on the cover.

AD-774 887/4CP PC **A02**/MF **A01**
George Washington Univ Washington D C Program in Logistics
Comparisons of Small-Sample Power for Tests of Exponentiality
Carl M. Harris. 1 Feb 74, 22p Rept no. Serial-T-286
Contract N00014-67-A-0214-0001

Descriptors: *Statistical tests, *Life tests, *Reliability, Mathematical prediction, Exponential functions, Monte Carlo method, Computer programs, Sampling.
Identifiers: Exponential density functions, N.

The paper is intended to provide some results to guide applied operations research analysts in the choice of a statistical test for determining whether a set of observations can be said to come from an exponential distribution. Power comparisons are made for a total of five tests against what are deemed to be the most popular alternatives for sample sizes of 10, 20, 30, and 40, and for a number of different possible parameter values. (Author)

AD-774 899/9CP PC **A03**/MF **A01**
Naval Ship Research and Development Center Bethesda Md
Accuracy and Precision of Algorithms for Bessel Functions of First Kind and Integer Order
T. Kooij. Oct 73, 38p Rept no. NSRDC-4259

Descriptors: *Bessel functions, *Computer programs, FORTRAN, Power series, Asymptotic series, Algorithms.
Identifiers: FORTRAN 4 programming language, CDC 6700 computers, N.

Three different algorithms--the power series, the asymptotic series, and the recurrence relation method--are investigated with special attention to the single (10 to the -14th power) and double precision (10 to the -29th power) of CDC 6000 Series computers. The final accuracy of each method depends partly on the magnitudes of the largest and smallest terms when floating point additions are involved. Another consideration is the number of terms required for each algorithm. Combination of all considerations leads to a partitioning of the order-argument domain into partially overlapping areas in which each algorithm is most appropriate. A wedged area not covered by any of the algorithms remains for large order and argument of approximately equal size. Orders and arguments up to 1024 were investigated and checked where possible. A FORTRAN IV program in the form of an external function is included. (Author)

AD-775 282/7CP PC **A03**/MF **A01**
Naval Postgraduate School Monterey Calif
Pattern Analysis: Method and Applications
Technical rept.
Ronald A. Weitzman. Sep 73, 42p Rept no. NPS-55WZ73091A

Descriptors: *Patterns, *Statistical analysis, Regression analysis, Discriminate analysis, Computations, Computer programs, Selection.
Identifiers: Psychometrics, N.

The report describes and illustrates a method of selecting items and scoring responses so as to produce maximal predictive validity for a specified criterion. The responses must be binary, e.g., correct/incorrect or yes/no. Results show that the method, stepwise pattern analysis, yields higher predictive validities for a small number of items than other methods do for many more. Through its ability to score both aptitude and biographical items together, moreover, pattern analysis can provide an automatic correction for possible test bias. (Author)

AD-775 404/7CP PC **A03**/MF **A01**
Ohio State Univ Columbus Dept of Geodetic Science
A FORTRAN 4 Program for the Inversion of a Large Symmetric Matrix by Block Partitioning
Pentti Karki. Sep 73, 46p* DGS-205, Scientific-12, AFCRL-TR-73-0714
Contract F19628-72-C-0120

Descriptors: *Matrices(Mathematics), *Computer programs, Computations, Compilers, Subroutines, FORTRAN.
Identifiers: FORTRAN 4 programming language, IBM 370/165 computers, *Matrix inversion, Partitions(Mathematics), AF.

A computer program to invert a large symmetric matrix is described in the report. The given upper triangular portion of a symmetric matrix is partitioned and inverse returned as a result. The minimum region required by the program is 252 K bytes which is still enough to invert a 10000 x 10000 symmetric matrix. If the matrix is not positive definite, a special bordering method (DBINV) is used to invert needed submatrices, otherwise a factorization method (DSINV) is used. The program requires two tape units, one for the input matrix, the other one for the resulting inverse. Four temporary direct access disk units are also needed. The program has been implemented on a IBM 370/165 computer with a maximum user available core of 630 K bytes, not all of which may be needed by the programs described in this report. (Author)

AD-775 828/7CP PC **A04**/MF **A01**
Picatinny Arsenal Dover N J
SPLIFIT - An Interactive Graphics Curve Fitting Computer Program Utilizing Spline Functions
Technical memo.
Miriam Harris. Jan 74, 64p Rept no. PA-TM-2126

Descriptors: *Interactive graphics, *Curve fitting, *Splines, Functions(Mathematics), Interpolation, FORTRAN.
Identifiers: SPLIFIT computer program, Spline interpolation, Cubic spline technique, A.

SPLIFIT is an interactive graphics program to curve fit for a maximum of 50 input points using cubic spline functions for the smoothing process. This method forces the fitted curve through the given points and has been compared to a draftsman hand fit using the mechanical spline as a tool. The method is most useful when there are very few input points to be curve fitted. Available interactive options include, among others, add points, delete points, rescale axes, and printer hard copy. The cubic splines derived are available as part of the printed output. (Author)

AD-776 215/6CP PC **E02**/MF **A01**
Naval Weapons Lab Dahlgren Va
A Point Mass Approximation of Surface Density
Technical rept.
James C. Perry. Feb 74, 22p Rept no. NWL-TR-3093

Descriptors: *Potential theory, Integral equations, Geodesy, Computer programs.
Identifiers: Point mass approximation, CDC 6700 computers, Spherical harmonics, COAT computer program, N.

The coating method is applied to a finite harmonic series to yield a mass density distribution on a sphere. Point mass approximations to this distribution are computed for use as initial values for computations based upon a point mass field. A CDC 6700 program for computing the point mass values is described and listed. (Author)

AD-776 339/4CP PC **A06**/MF **A01**
Harvard Univ Cambridge Mass Div of Engineering and Applied Physics
Algorithm for Computing the Parameterized Solution of a Family of Minimax Problems
Technical rept.
R. Muralidharan. Mar 74, 111p Rept no. TR-650
Contract N00014-67-A-0298-0006, Grant NSF-GK-31511

Descriptors: Minimax technique, Nonlinear programming, Convex sets, Steepest descent method, Theorems, Algorithms, Computer programs, FORTRAN.
Identifiers: FORTRAN 4 programming language, N.

The report documents the research done to develop a new algorithm for computing the parameterized solution to a family of minmax problems.

AD-776 391/5CP PC **A02**/MF **A01**
Picatinny Arsenal Dover N J
Least-Squares Fitting of Polynomial Equations. The Interactive Program POLYFIT
Technical rept.
Thomas E. Hayes, and George D. Six. Feb 74, 17p Rept no. PA-TR-4558

Descriptors: *Curve fitting, *Least squares method, *Computer programs, Polynomials, Time sharing, FORTRAN.
Identifiers: POLYFIT computer program, CDC 6500 computers, A.

A program, POLYFIT, has been converted to CDC FORTRAN Extended that provides true least-squares fits to bivariate data of equations of the form: y = (A sub 0) + (A sub 1)x + . . . + (A sub m)(x sub m).

AD-776 392/3CP PC **A02**/MF **A01**
Picatinny Arsenal Dover N J
Root Determination of Polynomial Equations with Real Coefficients
Technical rept.
Meir Baran, and George D. Six. Jan 74, 16p Rept no. PA-TR-4591

Descriptors: *Computer programs, *Equations, Polynomials, FORTRAN.
Identifiers: CDC 6500 computers, *Roots of equations, *Theory of equations, A.

A program has been written in CDC FORTRAN EXTENDED that provides the solution of polynomial equations of any degree with real coefficients of the form: y sup n + (A sub 1) y sup (n-1) + (A sub 2) y sup (n-2) + . . . + (A sub n) = 0. The program has been included in the permanent files of the Picatinny Arsenal CDC-6500 computer and may be accessed and used from any teletype connected to that facility. An explanation of the use of the program, an explanation and derivation of the mathematics on which it rests, and a listing of the program, in CDC FORTRAN EXTENDED are included in the report. (Modified author abstract)

AD-776 537/3CP PC **E03**/MF **A01**
Naval Postgraduate School Monterey Calif
Parameter Estimation for a Two-State Semi-Markov Model of a Univariate Point Process
Master's thesis
James Leroy Hornback. Mar 74, 40p

Descriptors: *Stochastic processes, Mathematical models, Random variables, Distribution functions, Partial differential equations, Computer programs, Memory devices, Theses.
Identifiers: Semi Markov processes, Parameter estimation, Maximum likelihood estimation, N.

Using the convenient second-order interval properties of a two-state semi-Markov model for a univariate point process, an automated technique for the estimation of the parameters in the model was researched and discussed. The power spectral density of intervals was estimated by the periodogram and a Kolmogorov-Smirnov test of fit was conducted. The asymptotic exponential distribution and independence of the periodogram points were used to calculate an approximate likelihood function. A system of equations was then formed to find the maximum likelihood estimates of the parameters. (Modified author abstract)

AD-776 910/2CP PC **A17**/MF **A01**
Army Research Office Durham N C
Proceedings of the Conference on the Design of Experiments in Army Research Development and Testing (18th) Held at Aberdeen Proving Ground, Maryland, on 25-27 October 1972. Part 1
Oct 73, 397p Rept no. AROD-73-2-Pt-1
See also Part 2, AD-776 911.

Descriptors: *Meetings, *Experimental design, *Army research, Mathematical models, Estimates, Confidence limits, Least squares method, Flight testing, Rocket research, Time series analysis, Bayes theorem, Computations, Computer programs.
Identifiers: Block design, Maximum likelihood estimation, A.

A partial listing of the contents is: Exploratory date analysis as part of a larger whole; The statistics of directions; An investigation of wind frequency response on the M50 rocket; Problems in designing experiments with large numbers of variables; Orthogonal estimates in weighing designs; Computer construction of balanced incomplete block designs; On spurious correlations for partially related variates; The least squares analysis of data generated by a piece-wise general linear model; Experimental establishment of accuracy of range-to-function measurements for artillery projectiles; An improved method of estimating the critical velocity of a projectile in penetration ballistics.

AD-777 523/2CP PC **A02**/MF **A01**
Harry Diamond Labs Washington D C
Hunting the Wild Hare: The Search for Anomalous Data Points
John S. Wicklund. Nov 73, 12p Rept no. HDL-TM-73-33

Descriptors: *Data processing, *Statistical analysis, Statistical tests, Probability density functions, Normal density functions, Computer programs.
Identifiers: APL programming language, A.

A method is given for the identification and isolation of anomalous data points in measurements that are being processed by a computer. A general discussion of the wild hare problem is presented, followed by a mathematical section and a section describing a computer program written in APL language which embodies the method. (Author)

AD-777 667/7CP PC **A02**/MF **A01**
Naval Research Lab Washington D C
Curve Fitting by Least Squares Analysis Using Matrix Inversion
Memorandum rept.
John Warner. Apr 74, 16p Rept no. NRL-MR-2774

Descriptors: *Computer programs, *Curve fitting, *Least squares method, Matrices(Mathematics), Plotters, Shift registers.
Identifiers: HP 9820A calculators, Matrix inversion, N.

A least squares fitting program written for the Hewlett Packard Model 9820A Calculator, is described. The program is versatile in the data entry format and in the type of function that it will fit to (i.e. not restricted to a power series). (Author)

AD-778 457/2CP PC **E04**/MF **A01**
Purdue Univ Lafayette Ind Dept of Statistics
Computational Uses of the Method of Phases in the Theory of Queues
Interim rept.
Marcel F. Neuts. Mar 74, 72p Mimeograph Ser-354, AFOSR-TR-74-0606
Grant AF-AFOSR-2331-72

Descriptors: *Queueing theory, *Probability density functions, Random variables, Stochastic processes, Algorithms, Computations, Computer programs.

A probability density on the positive integers is of phase type, if it is the probability density of the time till absorption in an (m+1)-state with one absorbing state m+1, and m transient states all of which lead to the absorbing state. If the service times in a discrete time queue have densities of phase type, several transient and stationary probability distributions of interest may be computed by highly efficient algorithms, which are presented in the paper. (Author)

AD-779 040/5CP PC **E01**/MF **A01**
Yale Univ New Haven Conn Dept of Administrative Sciences
A Computer Language for Mathematical Program Formulation
Interim rept.
Ronald E. Mills, and Robert B. Fetter. Apr 74, 25
Contract N00014-67-A-0097-0010, Grant PHS-HS-00163
Presented at ORSA/TIMS Joint Meeting, Boston, Mass., 22-24 Apr 74.

Descriptors: *Mathematical programming, *Compilers, Mathematical models, Syntax, Semantics.
Identifiers: CML(Conversational Modelling Language), Conversational modelling language.

Employing a Conversational Modelling Language (CML), a special computer language has been implemented to allow the specification of mathematical programming models and their parameterization. The language has been designed to be 'natural' in the mathematical programming context and to include interfaces with computer routines such as MPSX for optimization. Features implemented include equation writing, preparation of computer input, automatic checking and removal of redundancies, plus the ability to display solutions of such models given sufficient specification of decision variables. The system can prompt the user for incomplete model specification. Examples of the use of the language in building interactive decision support systems are given. (Author)

AD-779 109/8CP Reprint
Northwestern Univ Evanston Ill Dept of Geological Sciences
FORTRAN 4 Program for Spline-Surface Interpolation and Contour Map Production
M. E. V. Koellings, and E. H. T. Whitten. 9 Oct 73, 17p AROD-9894.4-EN
Grant DA-ARO-D-31-124-72-G54
Availability: Pub. in Geocom Programs, v9 p1-12 Dec 73.

Descriptors: *Splines, *Interpolation, *Computer programs, Matrices(Mathematics), Subroutines, FORTRAN.
Identifiers: *Bicubic splines, FORTRAN 4 programming language, *Spline interpolation.

A FORTRAN 4 computer program is presented for computing bicubic-spline-interpolation surfaces following de Boor's method. On the basis of gridded sample locations, the program permits continuous symbol contoured maps to be printed for the spline-surface values of the dependent variable. (Author)

AD-779 690/7CP PC **A04**/MF **A01**
Syracuse Univ N Y Dept of Electrical and Computer Engineering
APL Simulation Programs of Arithmetic Operations for an Associative Processor
Interim rept.
Wei-tih Cheng, and Tse-yun Feng. Mar 74, 65p TR-73-12, RADC-TR-74-66
Contract F30602-72-C-0281

Descriptors: *Associative processing, *Arithmetic, *Computer programs, Computations, Computerized simulation.
Identifiers: APL programming language, Arithmetic and logic units.

A number of algorithms for bis (bit-slice)-sequential arithmetic operations performed on an associative processors are simulated in APL. Some simulation programs are presented. Some descriptions of the simulation programs, as well as the necessary conditions to be set up, are also given. (Author)

AD-779 839/0CP PC **A03**/MF **A01**
Naval Research Lab Washington D C
A Second Order Runge-Kutta Integration Subroutine That Uses a Different Step-Size for Each Variable
Final rept.
Harold L. Toothman. May 74, 26p Rept nos. NRL-MR-2795, NRL-Computer Bull-37

Descriptors: *Computer programs, *Boundary value problems, *Runge Kutta method, Subroutines, FORTRAN, Numerical integration.
Identifiers: CDC 3800 computers.

The program was written to handle the numerical integration of initial value problems in which the frequency content of the variables differ considerably among themselves. In order to save computer time each variable is integrated with its own step-size so that the derivatives of the slowly changing variables are calculated less frequently than the derivatives of the rapidly changing variables. A second order Runge-Kutta method is used since high accuracy is not required. (Author)

AD-779 935/6CP PC **A04**/MF **A01**
Air Force Weapons Lab Kirtland AFB N Mex
Use of Optima for Solving Games
Final rept. 1 Sep 73-1 Dec 73
Karl T. Benson. Apr 74. 52p Rept no. AFWL-TR-74-18

Descriptors: *Game theory, *Nuclear warfare, *Strategy, *Optimization, Linear programming, Inequalities, Algorithms.
Identifiers: CDC 6600 computers, Two person games, Zero sum games, Matrix games, OPTIMA computer program.

Recent uses of a two-person, zero-sum game formulation for analysis within the Air Force Weapons Laboratory have resulted in a need to document the methodology and mechanics of solving games for their optimal strategies. The report describes the game formulation, the conversion of the game problem to an equivalent linear programming problem, the formulation of input for computer solution of this linear programming problem, and the location of the answers in the output. The software system used for the computations required to solve these mathematical programming problems on a CDC 6600 computer is called OPTIMA. All phases of the solution procedure are illustrated with appropriate examples. (Author)

AD-780 567/4CP PC **A12**/MF **A01**
Georgia Univ Athens Dept of Statistics and Computer Science
A Product Flow Analysis with Time-Dependence
Technical rept.
R. L. Wood. Dec 73, 251p Rept nos. TR-99, THEMIS-UGA-27
Contract N00014-69-A-0423

Descriptors: *Production control, *Queueing theory, *Computer programs, Network flows, Matrices(Mathematics), Distribution functions, Time lag theory, Mathematical models.
Identifiers: PRODFLOW computer program, M/M/s queue, Themis project.

The program PRODFLOW is an interactive program for analysis of a product flow assuming a linear model. The program allows for real time design and modification of any linear system and supplies tables of queue length with their corresponding probabilities as well as a graphic repre-

sentation. A transient analysis is also provided for a more detailed study of the system. (Author)

AD-780 568/2CP PC **A05**/MF **A01**
Georgia Univ Athens Dept of Statistics and Computer Science
Curve Fitting by the Method of Moments
Technical rept.
Hubert Bouver. Dec 73, 90p Rept nos. TR-102, THEMIS-UGA-29
Contract N00014-69-A-0423

Descriptors: *Curve fitting, Distribution functions, Normal density functions, Weibull density functions, Computer programs, Statistical tests.
Identifiers: *Method of moments, Lognormal density functions, Pearson density functions, Gamma function, Chi square test, Goodness of fit tests.

The purpose of the report is to present a method of graduating observed frequency distribution using a computer package which is designed to aid the user in choosing among several distributions the frequency curve that will best fit his data. (Author)

AD-780 587/2CP PC **A03**/MF **A01**
Air Force Weapons Lab Kirtland AFB N Mex
LINPR: A Code to Solve Linear Programming Problems and Two-Person Zero-Sum Games
Final rept. 1 Feb-1 Mar 74
Harry F. Doyle. May 74, 32p Rept no. AFWL-TR-74-35

Descriptors: *Linear programming, *Game theory, Strategy, Computer programs, FORTRAN, Algorithms.
Identifiers: Two person games, Zero sum games, LINPR computer program.

LINPR is a FORTRAN language computer-coded simplex algorithm. The code was originally developed to solve linear programming problems and has recently been modified to also solve two-person zero-sum games. This description of the code presents the necessary details to use LINPR to solve linear programming problems and/or two-person zero-sum games. (Author)

AD-780 779/5CP PC **A05**/MF **A01**
Naval Underwater Systems Center New London Conn New London Lab
Nonlinear Multistep Methods for Solving Initial Value Problems in Ordinary Differential Equations
Technical rept.
Ding Lee. 24 May 74, 100p Rept no. NUSC-TR-4775

Descriptors: *Differential equations, *Boundary value problems, Numerical analysis, Matrices(Mathematics), Difference equations, Approximation, Stability, Theorems, FORTRAN, Computer programs.
Identifiers: *Nonlinear multistep methods, UNIVAC 1108 computers, FORTRAN 5 programming language, Stiff differential equations.

The report develops a family of Nonlinear Multistep (NLMS) numerical methods which solve initial value problems for systems of first-order differential equations. These methods are demonstrated to be a generalization of Linear Multistep (LMS) methods and are formulated to be particularly effective for equations whose solutions are asymptotically stable. The formal theory of NLMS methods with regard to stability, consistency, and convergence is fully developed and proved. NLMS methods are strongly stable and accommodate A-stability in the sense of Dahlquist. Extensive numerical test results produced by NLMS methods show important advantages over Adams' and Gear's methods and Ehle's test results. (Author)

AD-781 003/9CP PC **E05**/MF **A01**
Teledyne Brown Engineering Huntsville Ala Military Systems Div
A Computer Simulation to Determine Kinematic Interceptor Performance
Technical rept.
W. M. Langley. Dec 73, 98p Rept no. MSD-74-ABMDA-1784
Contract DAHC60-73-C-0017

Descriptors: *Antimissile defense systems, *Intercept trajectories, *Computerized simulation, Radar tracking, Mathematical models, Computer programs.
Identifiers: KIP computer program, CDC 7600 computers.

The equations of motion describing an interceptor engaging an exoatmospheric target were derived and programed into a computer simulation. The simulation (KIP-KINEMATIC INTERCEPTOR PERFORMANCE) is capable of determining interceptor preliminary performance requirements in terms of relative geometry and required velocity. Engagement constraints, such as baffle angle and radar horizon, are considered. A description of the KIP simulation is included in the Appendices. (Author)

AD-781 286/0CP PC **A06**/MF **A01**
Union Coll Schenectady N Y Inst of Administration and Management
Nonparametric Truncated Sequential Test for the Median with Application to Maintainability
Final rept. Jun 72-Dec 73
Thomas I. Goss. Dec 73, 122p Rept no. AES-745
Contract N00014-72-A-0507-0001

Descriptors: *Sequential analysis, *Distribution functions, Statistical tests, Confidence limits, Mean, Maintainability, Computer programs, Tables(Data), Theses.
Identifiers: Nonparametric statistics.

Truncated sequential procedures, using the binomial distribution, are provided for a nonparametric test of the median of a distribution. Applications are made to maintainability tests. Sequential estimation and confidence limits are given. The methods are perfectly general for nonparametric tests of any percentile of a distribution. (Author)

AD-781 287/8CP PC **A05**/MF **A01**
Union Coll Schenectady N Y Inst of Administration and Management
Truncated Sequential Test for the Variance of a Normal Distribution with Applications to Maintainability
Final rept. Jun 72-Dec 73
Thomas I. Goss. Dec 73, 84p Rept no. AES-746
Contract N00014-72-A-0507-0001

Descriptors: *Sequential analysis, *Distribution functions, *Statistical tests, Analysis of variance, Normal density functions, Tables(Data), Maintainability, Computer programs, Theses.
Identifiers: *Lognormal density functions.

A truncated sequential test on the variance of a normal distribution is applied to a maintainability demonstration test for one of the parameters of a lognormal distribution by noting that if X is lognormal, log X is normal. A variety of cases are evaluated and examples are given. The results are based on Aroian's direct method. (Author)

AD-781 369/4CP PC **A04**/MF **A01**
Naval Postgraduate School Monterey Calif
Some Methods for Approximating Functions of Several Variables
Technical rept. Feb-Mar 74
Richard Franke. May 74, 61p Rept no. NPS-53FE74051

Descriptors: *Functions(Mathematics), *Approximation, Interpolation, Least squares method, Computer programs, FORTRAN, Tables(Data).
Identifiers: MINMAX computer program, LSTSQ computer program, FORTRAN 4 programming language.

Some methods of approximating discrete functions of several variables were investigated. The principal goal was a suitable approximation for aerodynamic and infrared signature data for use in real time hybrid computer simulations. The main thrust is toward approximation by sums of functions of fewer variables. Two computer programs are given, and a number of comparisons between three types of approximations are given. It is decided that no method for determining, a priori, the kind of approximation which will yield suitable results is known, except in special cases. (Author)

AD-781 742/2CP PC **A02**/MF **A01**
Arizona State Univ Tempe Dept of Mathematics
Computation of Nu-Splines
Technical rept.
Gregory M. Nielson. Jun 74, 20p Rept no. TR-11
Contract N00014-72-A-0070-0002

Descriptors: *Splines, *Interpolation, Curve fitting, Computer programs.
Identifiers: *Mu splines, *Spline interpolation.

The report contains the description and subprograms for the generation of mu-splines. These planar interpolants, which are piecewise polynomials, serve as alternatives to the parametric splines in tension, which are piecewise functions of the form a + bt + c.sinh(alpha t) + d.cosh(alpha t). (Author)

AD-781 871/9CP PC **A02**/MF **A01**
State Univ of New York Buffalo Statistical Lab
TIMESBOARD: A Time Series Package
Technical rept.
M. Pagano, and E. Parzen. Dec 73, 7p Rept no. TR-3
Contract N00014-72-C-0508

Descriptors: *Time series analysis, Mathematical prediction, Fourier transformation, Computer programming, Algorithms.
Identifiers: TIMESBOARD computer program, Parameter estimation, Fast Fourier transform.

TIMESBOARD is a collection of subroutines designed to aid the analyst in model identification, parameter estimation and prediction of time series. When competing algorithms were available for a particular task, the one with the most favorable numerical characteristics was chosen. (Author)

AD-782 301/6CP PC **E03**/MF **A01**
Lockheed Missiles and Space Co Inc Sunnyvale Calif
Variable Grid Finite Difference-Element Solution of Elliptic Partial Differential Equations
Interim rept.
Paul S. Jensen, and Carlos A. Felippa. 13 May 74, 56p LMSC-D401891, AFOSR-TR-74-1036
Contract F44620-71-C-0109
See also report dated 26 Jun 72, AD-746 045.

Descriptors: *Loads(Forces), *Structural members, *Finite difference theory, *Partial differential equations, Plates, Numerical integration, Computer programming.
Identifiers: Biharmonic difference equations, Elliptic differential equations, *Finite element analysis, FIDAG computer program, *Structural analysis.

A hybrid finite difference-finite element technique for elliptic partial differential equations, which operates on arbitrary discretization grids, is formulated. The technique has been implemented, and extensive results are given for the bi-harmonic equation. (Author)

AD-782 517/7CP PC **A02**/MF **A01**
Naval Ship Research and Development Center Bethesda Md Computation and Mathematics Dept
Guidelines for Use of the HRB-Singer 'OPTIMIZER' in the Solution of Optimization Problems through Computer Simulation
Final rept.
Jay Mandelbaum. Dec 73, 15p Rept no. CMD-17-74

Descriptors: *Optimization, Computerized simulation, Problem solving.
Identifiers: OPTIMIZER computer program.

The HRB-Singer Company has developed an automatic OPTIMIZER program to aid in the solution of complex optimization problems requiring computer simulation. A series of demonstration problems solved by both a human analyst and the OPTIMIZER serve as a basis for an evaluation of the usefulness of the OPTIMIZER. One conclusion reached

was that the OPTIMIZER can usually greatly reduce the time to solution. In addition, when an analyst unfamiliar with the problem at hand uses the OPTIMIZER, there is potential substantial benefit in that a good solution, better than the unaided analyst could have achieved, can be attained. (Author)

AD-782 566/4CP PC A06/MF A01
Naval Ship Engineering Center Philadelphia Pa Philadelphia Div
Collection of Algorithms for the Integration of Ordinary Differential Equations on a Digital Computer
Final rept.
A. M. Loeb, and J. Cohen. 21 Jun 74, 101p Rept no. NAVSECPHILAD-C-69-4

Descriptors: *Differential equations, *Numerical integration, *Computer programs, Digital computers, Subroutines, FORTRAN.
Identifiers: Ordinary differential equations, FORTRAN 4 programming language.

In the continuing effort on this project to develop new and improved methods for the numerical solution of ordinary and partial differential equations, several useful and important FORTRAN subroutines have been collected to solve problems at NAVSECPHILADIV. It is the purpose of this report to discuss these subroutines with particular emphasis on their application to practical problems. With these subroutines the user may solve a wide spectrum of engineering and scientific problems involving ordinary differential equations. (Author)

AD-782 705/8CP PC A09/MF A01
Georgia Univ Athens Dept of Statistics and Computer Science
Tables of the Standardized Percentage Points of the Pearson System of Curves in Terms of Beta 1 and Beta 2
Technical rept.
Hubert Bouver, and Rolf E. Bargmann. Jun 74, 193p Rept nos. TR-107, THEMIS-UGA-32
Contract N00014-69-A-0423

Descriptors: *Analysis of variance, *Distribution functions, Probability density functions, Curve fitting, Computer programs, FORTRAN.
Identifiers: Themis project, Pearson density functions, Gamma function, Beta function, FORTRAN 4 programming language, CDC 6400 computers.

The purpose of the technical report is to present tables of the standardized percentage points of the Pearson system of curves in terms of (beta sub 1) and (beta sub 2) and to give a computer package for the entire (beta sub 1), (beta sub 2) plane of the pearsonian system which will evaluate the percentage point, the probability level and the probability density function of a given standardized variate. (Author)

AD-782 706/6CP PC A12/MF A01
Georgia Univ Athens Dept of Statistics and Computer Science
Internal Multi-Dimensional Scaling of Categorical Variables
Technical rept.
Jeffrey Chit-Fu Chang, and Rolf E. Bargmann. Jul 74, 258p Rept nos. TR-108, THEMIS-UGA-34
Contract N00014-69-A-0423

Descriptors: *Multivariate analysis, Matrices(Mathematics), Correlation techniques, Set theory, Control sequences, Computer programs, FORTRAN.
Identifiers: Maximum likelihood estimation, Contingency tables, Themis project, FORTRAN 4 programming language.

The purpose of the study in the dissertation is to translate raw categorized data into numerical values on which standard statistical analyses can be performed. When raw observations are recorded on a nominal scale, they are to be transformed so that the resulting numbers can be regarded as lying on an interval scale. A scalling technique is developed on the basis of a generalization of Lancaster's approach (canonical correlation for two sets). The report also presents computer programs starting from data in contingency tables which are converted into a correlation matrix. Initial values are used in order to start the minimum-determinant process. Various initial weights and the final minumum-determinant solution are compared. (Modified author abstract)

AD-783 893/1CP PC A11/MF A01
Georgia Univ Athens Dept of Statistics and Computer Science
Structure and Distance of Logical Patterns. Appendix. Volume I
Final rept.
Rolf Bargmann. Jul 74, 233p Rept no. THEMIS-UGA-33-Vol-1
Contract N00014-69-A-0423
See also AD-728 427.

Descriptors: *Statistical analysis, *Pattern recognition, Estimates, Matrices(Mathematics), Computer programs, Subroutines, FORTRAN, Distribution functions, Tables(Data).
Identifiers: Themis project, FORTRAN 4 programming language.

The author illustrates some of the techniques of the previous chapters by considering two numerical examples. These examples were constructed on the basis of artificial sets of parameters. In Example I, a set of 13 diagnostic events each being in 2 states was observed assuming a major event in 3 states, whereas in Example II, a set of 15 diagnostic events, each being in 3 states, was observed assuming a major event in 2 states. In each example, time-dependence of rows has been assumed.

AD-783 894/9CP PC A13/MF A01
Georgia Univ Athens Dept of Statistics and Computer Science
Structure and Distance of Logical Patterns. Appendix. Volume II
Final rept.
Rolf Bargmann. Jul 74, 288p Rept no. THEMIS-UGA-33-Vol-2
Contract N00014-69-A-0423
See also AD-783 893.

Descriptors: *Statistical analysis, *Pattern recognition, Distribution functions, Computer programs, FORTRAN, Subroutines.
Identifiers: Themis project, FORTRAN 4 programming language.

The report contains appendices F, G and H of the Themis Project study 'Structure and Distance of Logical Patterns'.

AD-783 895/6CP PC A15/MF A01
Georgia Univ Athens Dept of Statistics and Computer Science
Structure and Distance of Logical Patterns. Appendix. Volume III
Final rept.
Rolf Bargmann. Jul 74, 331p Rept no. THEMIS-UGA-33-Vol-3
Contract N00014-69-A-0423
See also AD-783 894.

Descriptors: *Statistical analysis, *Pattern recognition, Distribution functions, Multivariate analysis, Computer programs, FORTRAN.
Identifiers: Themis project, FORTRAN 4 programming language.

The report contains appendices I, J, K and L of the Themis project study 'Structure and Distance of Logical Patterns'.

AD-784 028/3CP PC A05/MF A01
Army Materiel Command Texarkana Tex Intern Training Center
An Economic Approach to Acceptance Sampling
Final rept.
Robert Justin Ruth. Mar 73, 80p* Rept no. USAMC-ITC-2-73-19

Descriptors: *Quality assurance, *Sampling, Economics, Consumers, Acceptability, Decision theory, Probability density functions, Computer programs.
Identifiers: *Acceptance sampling, *Economic analysis, Consumer protection, Acceptable quality level.

The paper examines the economics of single sample acceptance sampling with the objective of determining a rational, consistent means of selecting a sampling plan. Three general situations are identified for which cost models are developed. These include: (1) non-destructive sampling with rectification of rejected lots, (2) non-destructive sampling without rectification, and (3) destructive sampling. A method, suitable for use on a computer, is developed which identifies the optimal sampling plan for each of the above situations. In the paper, the optimal sampling plan is taken to be that which minimizes the consumer's total operating costs per accepted lot. (Author)

AD-784 029/1CP PC A06/MF A01
Army Materiel Command Texarkana Tex Intern Training Center
Optimizing Multistage Plants for Location and Size
Final rept.
Richard C. Green. Mar 73, 106p Rept no. USAMC-ITC-2-73-11

Descriptors: *Industrial plants, *Site selection, *Dynamic programming, Production, Transportation, Costs, Mathematical models, Computer programs, Optimization, FORTRAN, Theses.
Identifiers: FORTRAN 4 programming language.

The paper examines the problem of determination of plant size - specifically plants with multistages and locations. The possibility of locating one or more stages at a single location is also evaluated. Demand centers and transportation cost to final destinations and between stages are also part of the problem. This problem is solved using dynamic programming and a computer program was written to work the problem. Dynamic programming handles the problem of evaluation of all feasible assignments of stages and plants to all locations in an orderly fashion. An example problem is worked through, and the output from the computer for solving this problem is also included. (Author)

AD-784 035/8CP PC A04/MF A01
Army Materiel Command Texarkana Tex Intern Training Center
Determination of Sample Size Required in Life Testing to Estimate the Parameter of the Exponential Distribution
Final rept.
Thomas Herbert Nathan. Mar 73, 70p Rept no. USAMC-ITC-2-73-16

Descriptors: *Reliability, *Sampling, *Statistical tests, *Life tests, Failure, Estimates, Computer programs, Exponential functions, Computerized simulation, Theses.
Identifiers: Parameter estimation, Exponential density functions.

The paper shows the procedure in the development of a test statistic which will determine the sample size required to estimate the parameter of the exponential distribution. The paper assumes that the time-to-failure data is from life testing without replacement. An estimator is developed by regression, by fitting the time-to-failure data to a theoretical cumulative distribution. A computer simulation is performed which shows the calculation of the test statistic and evaluates the estimator developed in the paper. (Author)

AD-784 040/8CP PC E02/MF A01
Army Materiel Command Texarkana Tex Intern Training Center
A Procedure for the Truncation of the Probability Ration Sequential Test Plans of MIL-STD-781B
Final rept.
Francis A. Martin. Mar 73, 82 Rept no. USAMC-ITC-2-73-14

Descriptors: *Quality assurance, *Sampling, *Risk, Reliability, Sequential analysis, Acceptance tests, Military requirements, Computer programs, FORTRAN.

Identifiers: FORTRAN 4 programming language, Probability ratio tests.

This research is designed to develop a procedure for the truncation of the Probability Ratio Sequential Test plans in MIL-STD-781B which will improve upon the present technique by obtaining less variance in the truncated risks of the test plans. In accomplishing this goal, an analysis of variations in the intercepts and slopes of the accept/reject lines was performed. In order to observe the change in the producer's risk (alpha) and the consumer's risk (beta) a computer program was developed which evaluated these risks while varying the slopes and intercepts of the accept/reject lines. The final procedure developed employs the use of a program of this type. (Modified author abstract)

AD-784 095/2CP PC **A04**/MF **A01**
Army Materiel Systems Analysis Activity Aberdeen Proving Ground Md
A Computer Program for Estimation of Parameters of the Weibull System Failure Rate Function
Technical rept.
Edward F. Belbot. May 74, 55p Rept no. AMSAA-TR-99

Descriptors: *Reliability, *Statistical analysis, Weibull density functions, Estimates, Computer programs, FORTRAN.
Identifiers: Failure rate functions, Parameter estimation, Maximum likelihood estimation.

The estimation of the parameters of the Weibull system failure rate function requires, in general, the use of an iterative procedure. This report describes the structure and use of a digital computer program in FORTRAN, which can be used to obtain these estimates. (Author)

AD-784 998/7CP PC **A04**/MF **A01**
Washington Univ Seattle Dept of Mathematics
Shelling Algorithms
Technical rept.
Goapl Danaraj, and Victor Klee. Aug 74, 75p Rept no. TR-49
Contract N00014-67-A-0103-0003

Descriptors: *Topology, *Combinatorial analysis, Convex sets, Linear programming, Theorems, Computer programs.
Identifiers: Convex polytopes, Graph theory.

A shelling of a simplicial n-manifold is a permutation S sub 1,...,(S sub m) of its n-simplices. Shellings have been studied in connection with the topology of manifolds and the combinatorial geometry of convex polytopes. This paper presents algorithms for finding shellings of a given pseudomanifold M or concluding they do not exist. (Modified author abstract)

AD-785 119/9CP PC **A05**/MF **A01**
Purdue Univ Lafayette Ind
Some New Algorithms for Deterministic and Probabilistic Communication Networks
Phase rept.
P. M. Lin, B. J. Leon, T. C. Huang, and R. Krzyzanowski. Jun 74, 92p RADC-TR-74-150
Contract F30602-72-C-0438

Descriptors: *Communications networks, *Network flows, Routing, Reliability, Mathematical models, Computer programs.
Identifiers: *Graph theory.

The objective of the effort reported herein is twofold: to develop more efficient algorithms for communication networks and to implement the algorithms. Two problems are included: the maximum flow problem and the terminal-pair reliability problem. For the maximum flow problem, a new labeling algorithm has been proposed. A complete documentation of the computer program is included. (Author)

AD-785 289/0CP PC **A02**/MF **A01**
Southern Methodist Univ Dallas Tex Dept of Statistics
Description of LATANAL, A Computer Program for Latent Root Regression Analysis
Technical rept.
Richard F. Gunst, John T. Webster, and Robert L. Mason. 10 May 74, 25p Rept no. TR-116
Contract N00014-72-A-0296

Descriptors: *Regression analysis, *Computer programs, Least squares method, Mathematical prediction, FORTRAN.
Identifiers: LATANAL computer program, FORTRAN 4 programming language.

The purpose of this paper is to present a computer program which will perform the calculations needed for latent root regression analysis. Latent root regression is a technique proposed by the authors to supplement ordinary least squares when multicollinearity exists in the matrix of regression variables. Included in the paper is a discussion of input and output for the program. references for a discussion of the technique, a program listing, and sample output. (Author)

AD-785 496/1CP PC **A07**/MF **A01**
Army Materiel Command Texarkana Tex Intern Training Center
Analytical Evaluation of a Sparing Technique Applicable during Early Configuration Development
Final rept.
William J. Vanden Bosch. Mar 73, 136p Rept no. USAMC-ITC-02-08-73-003

Descriptors: *Reliability, *Statistical analysis, Spare parts, Maintainability, Probability density functions, Normal density functions, Analysis of variance, Failure, Computer programs, FORTRAN.
Identifiers: Weibull density functions, FORTRAN 4 programming language.

This paper establishes the accuracy of a sparing technique applicable during early configuration development by comparing it to an analytical solution of the sparing problem. Testing of the prediction technique was accomplished for three basic time to failure density functions under a wide range of sparing configuration arrangements. Quantities varied for each probability density function included type of sparing configuration, length of sparing time interval, and type of sparing process. (Modified author abstract)

AD-785 503/4CP PC **A06**/MF **A01**
Army Materiel Command Texarkana Tex Intern Training Center
Sample Size Determination for Estimating Parameters of the Exponential Distribution
Final rept.
John Lewis Andress. Mar 74, 105p Rept no. USAMC-ITC-02-08-73-101

Descriptors: *Reliability, *Sampling, *Statistical tests, Failure, Probability density functions, Monte Carlo method, Computerized simulation, Exponential functions, Computer programs.
Identifiers: F test, Parameter estimation, *Exponential density functions.

This paper shows the development of a method for the estimation of the parameters of the exponential and rectangular distributions. An unsuccessful attempt is made to show that all but random error is eliminated by the use of an F test statistic. The assumption is made the failure-times are from life testing without replacement. The estimators are developed by regression and fitting of the failure data to a theoretical cumulative distribution. Computer simulations are employed to calculate the estimator and the test statistic. (Author)

AD-785 943/2CP PC **A04**/MF **A01**
Technology Inc Dayton Ohio
The ARL Linear Algebra Library Handbook
Interim technical rept. 1 Sep 73-31 Mar 74
Paul J. Nikolai, and Nai-kuan Tsao. Jul 74, 67p* ARL-74-0106
Contract F33615-73-C-4155

Descriptors: *Linear algebra, *Computer programs, Linear algebraic equations, Matrices(Mathematics), Eigenvectors, FORTRAN, Computations, Instruction manuals.
Identifiers: CDC 6000 computers, CDC 7000 computers, Eigenvalues.

The purpose of this report is to provide a companion volume to the ARL Linear Algebra Library. This library is a collection of numerical linear algebra programs written in the FORTRAN language, and developed on the CDC 6000/7000 series processors. The contents of this report feature the machine-printed documentation currently furnished in a machine-readable medium with each program in the library. Included in the library is a comprehensive selection of programs for solving linear algebraic equations and for the determination of eigenvalues and eigenvectors of real symmetric matrices. Unique features of the library include a translation into ANSI FORTRAN of the RITZIT algorithm of H. Rutishauser and the rational QL algorithm of C. Reinsch. (Modified author abstract)

AD-786 311/1CP PC **A02**/MF **A01**
Center for Naval Analyses Arlington Va
User's Guide for Generalized Factor Analysis Program (FACTAN)
Peter H. Stoloff. Aug 74, 10p Rept no. CNA-professional paper-106-add
Addendum to report dated Feb 73, AD-758 824.

Descriptors: *Factor analysis, *Computer programming, Sampling, Computations.
Identifiers: FACTAN computer program.

Subsequent to the distribution of the paper, certain corrections and additions to FACTAN have been implemented. Extensive use of the program has uncovered a number of 'bugs' in both the program and documentation which have been corrected. Recent innovations in the 'art' of factor analysis have produced measures of goodness-of-fit which have been incorporated. Also, planned changes to the CNA computer system have necessitated that the program be limited to one core-bank. These and other changes are described.

AD-786 475/4CP PC **A13**/MF **A01**
Georgia Univ Athens Dept of Statistics and Computer Science
Structure and Distance of Logical Patterns. Appendix. Volume IV
Final rept.
Rolf Bargmann. Jul 74, 294p Rept no. THEMIS-UGA-33-Vol-4
Contract N00014-69-A-0423
See also Volume 3, AD-783 895 and Volume 5, AD-786 476.

Descriptors: *Statistical analysis, *Pattern recognition, Computer programs, Subroutines, Statistical tests, Stochastic processes, Mathematical models.
Identifiers: Themis project.

The report contains appendices M, N, O, P, and Q of the Themis project study 'Structure and Distance of Logical Patterns' with the appropriate subroutines for statistical analysis.

AD-786 476/2CP PC **A13**/MF **A01**
Georgia Univ Athens Dept of Statistics and Computer Science
Structure and Distance of Logical Patterns. Appendix. Volume V
Final rept.
Rolf Bargmann. Jul 74, 291p Rept no. THEMIS-UGA-33-Vol-5
Contract N00014-69-A-0423
See also Volume 4, AD-786 475 and Volume 6, AD-786 493.

Descriptors: *Statistical analysis, *Pattern recognition, Computer programs, Subroutines, Statistical tests, Stochastic processes, Mathematical models.
Identifiers: Themis project.

The report contains appendices R, S, T, and U of the Themis Project study 'Structure and Distance of Logical Patterns' with appropriate subroutines for statistical analysis.

AD-786 493/7CP PC **A12**/MF **A01**
Georgia Univ Athens Dept of Statistics and Computer Science
Structure and Distance of Logical Patterns. Appendix. Volume VI
Final rept.
Rolf Bargmann. Jul 74, 262p Rept no. THEMIS-UGA-33-Vol-6
Contract N00014-69-A-0423
See also Volume 5, AD-786 476.

Descriptors: *Statistical analysis, *Pattern recognition, Computer programs, Subroutines, Statistical tests, Stochastic processes, Mathematical models.
Identifiers: Themis project.

The report contains appendices V, W, X and Y of the Themis project study 'Structure and Distance of Logical Patterns' with the appropriate subroutines for statistical analysis.

AD-786 530/6CP PC **A05**/MF **A01**
Watervliet Arsenal N Y
User's Guide for Adaptive Statistical Processor Program (APROC)
Technical rept.
F. J. Rich. Jul 74, 81p Rept no. WVT-TR-74032

Descriptors: *Statistical analysis, *Computer programming, FORTRAN, Monte Carlo method, Sampling, Standard deviation, Correlation techniques, Regression analysis, Instruction manuals.
Identifiers: APROC computer program.

This manual describes a computer program called the Adaptive Statistical Processor or APROC, written in FORTRAN for the purpose of calculating statistical information from random data vectors output by a Monte' Carlo simulation program or from some other suitable source of random data. The basic features of the program and all input parameters are described in the manual. The program can calculate sample means, standard deviations, covariance and correlation matrices (linear regression analysis), can calculate and plot sample cumulative distribution functions, and perform a Kolmogorov-Smirnov goodness of fit test. The program output is printed in a neat, well labelled, easy to read format. (Author)

AD-786 696/5CP PC **A03**/MF **A01**
Naval Ship Research and Development Center Bethesda Md
The Performance on the CDC 6400 of a Rheinboldt-Mesztenyi Program for Solving Large Sparse Symmetric Systems of Linear Equations
Research and development rept.
Donald A. Gignac. Jul 74, 26p Rept no. NSRDC-4496

Descriptors: *Linear algebraic equations, *Computer programs, *Computations, Matrices(Mathematics), FORTRAN.
Identifiers: CDC 6400 computers, Sparse matrix.

On the CDC 6400 computer this FORTRAN Extended version of the Rheinboldt-Mesztenyi computer program for solving sparse symmetric matrix equations was tested with respect to certain sample problems representative of structural analysis problems. This program does not appear to be competitive with CSKYDG, another linear equation solver. Lack of several special features in the CDC 6400 instruction set results in high overhead for manipulating the data structures used. (Author)

AD-787 316/9CP PC **A04**/MF **A01**
Picatinny Arsenal Dover N J
SPLIFIT: An Interactive Graphics Curve Fitting Computer Program Utilizing Spline Functions
Miriam Harris. Jan 74, 66p* Rept no. PA-TR-4677
Supersedes report dated Jan 74, AD-775 828.

Descriptors: *Interactive graphics, *Computer programming, *Curve fitting, *Splines, Plotters, FORTRAN.
Identifiers: *SPLIFIT computer program, Cubic spline technique, CDC 6500 computers.

SPLIFIT is an interactive graphics program to curve fit for a maximum of 50 input points using cubic spline functions for the smoothing process. This method forces the fitted curve through the given points and has been compared to a draftsman hand fit using the mechanical 'spline' as a tool. The method is most useful when there are very few input points to be curve fitted. Available interactive options include, among others, ADD POINTS, DELETE POINTS, RESCALE AXES, and printer HARD COPY. The cubic splines derived are available as part of the printed output. (Author)

AD-787 492/8CP PC **A06**/MF **A01**
Illinois Univ Urbana Coordinated Science Lab
A Basic Design of a Microprogrammed Function Evaluator
James Edward Smith. Aug 74, 109p Rept nos. R-658, UILU-ENG-74-2224
Contract DAAB07-72-C-0259

Descriptors: *Digital computers, *Microprogramming, *Transcendental functions, *Computations, Computer programs, Logic devices, Algorithms, Theses.
Identifiers: *Sigma 5 computers, FORTRAN 4 programming language, Logic design.

Since the Xerox Sigma 5 computer being used by the Materials Research Laboratory at the University of Illinois is primarily used for numerical computation, and since the evaluation of basic transcendental functions is a major part of many computations, it has been proposed that the hardware evaluation of these functions would lead to both faster and more accurate calculations. This report contains a basic design for a hardware function evaluation processor as well as the results of detailed simulations which make time and accuracy comparisons between hardware and software evaluation possible. The information presented here should provide some answers concerning the feasibility of building a hardware processor to evaluate numerical functions. (Author)

AD-787 588/3CP PC **A04**/MF **A01**
Carnegie-Mellon Univ Pittsburgh Pa
A Stable Variant of the Secant Method for Solving Nonlinear Equations
Interim rept.
W. B. Gragg, and G. W. Stewart. Apr 74, 59p
Contract N00014-67-A-0128-0018

Descriptors: *Nonlinear algebraic equations, *Iterations, Matrices(Mathematics), Computations, Algorithms, Computer programs.
Identifiers: *Secant method.

The usual successive secant method for solving systems of nonlinear equations suffers from two kinds of instabilities. First the formulas used to update the current approximation to the inverse Jacobian are numerically unstable. Second, the directions of search for a solution may collapse into a proper affine subspace, resulting at best in slowed convergence and at worst in complete failure of the algorithm. In this report it is shown how the numerical instabilities can be avoided by working with factorizations of matrices appearing in the algorithm. Moreover, these factorizations can be used to detect and remedy degeneracies among the directions. A second part of this report documents and lists a program implementing the algorithm described in the first part. (Author)

AD-787 597/4CP PC **A07**/MF **A01**
Union Coll Schenectady N Y Inst of Administration and Management
Truncated Sequential Test for a Three-Way Decision Procedure for Testing the Mean of a Normal Distribution with Known Variance
Final rept. Jun 72-Dec 73
Thomas I. Goss. Dec 73, 148p Rept no. AES 7411
Contract N00014-72-A-0507-0001

Descriptors: *Decision theory, *Statistical tests, Sequential analysis, Normal density functions, Mean, Analysis of variance, Sampling, Computer programs.

This report deals primarily with the theory and construction of exact truncated sequential tests for a three-way decision procedure for testing the mean of a normal distribution with known variance. The tables that are developed include the following test properties for certain two-sided truncated sequential tests of the mean of a normal distribution with variance known: the exact operating characteristic (O.C) function, the exact distribution of the decisive sample number (D.S.N.), the exact average sample number (A.S.N.) function, the median sample number (M.S.N.) function, the probability of termination of the test (P.T.T.) at any step, and a direct comparison with the equivalent fixed size test. (Modified author abstract)

AD-787 854/9CP PC **A03**/MF **A01**
Washington State Univ Pullman Dept of Computer Science
Least Squares Computations with Two Algorithms for the Two-Multiply, Two-Add Givens Rotation
Richard J. Hanson. 1974, 32p Rept no. WSU-CS-73-002
Contract N00014-68-A-0410-0004

Descriptors: *Matrices(Mathematics), *Least squares method, *Computations, Addition, Transformations(Mathematics), Arithmetic, Computer programs.
Identifiers: Multiplication, Givens transformation.

Two numerically stable algorithms for implementation of the two-multiply, two-add Givens transformation are discussed. An application of the use of these algorithms is given for the problem of accumulating and deleting rows of data from a least squares problem in a stable manner. The construction of the transformation requires essentially the same amount of work. The first method (which is not due to the author) requires no square roots but may require rescaling to avoid underflow and overflow. The second method requires one square root per transformation but will need rescaling less than half as often as the first method. (Author)

AD-822 235/CP PC **A02** MF **A01**
Redstone Scientific Information Center, Redstone Arsenal, Ala. Translation Branch.
Numerical Digital Computer Method for Determining the Transient Responses of Nonlinear Automatic Systems Based on Calculation of the Convolution Integral
A. V. Vulfson. 9 Aug 67, 17p RSIC-697
Trans. of Izvestiya Vysshikh Uchebnykh Zavedenii. Elektromekhanika (USSR) n8 p841-848 1965. Distribution Limitation now Removed.

Descriptors: *Nonlinear systems, Numerical analysis, *Transients, Nonlinear systems, Mathematical models, Integrals, Digital computers, Automatic, Transfer functions, Differential equations, Feedback, Graphics, Programming(Computers), USSR.
Identifiers: Convolution integrals, *Translations.

Discussed is a technique for the digital computer calculation of transient processes for systems with one or more nonlinear characteristics, using an extension of the convolution technique developed by Carson for systems with one nonlinearity. The method does not require formulation of a system of first-order differential equations with subsequent programming of the right-hand sides for each problem. The output data are transfer functions of the linear part of the system. The procedure for programming the solution of a specific problem is simplified, reducing essentially to the mere input of numerical data. The nonlinearities may be given tabularly, and they may be discontinuous. (Author)

AD-824 826/CP HC A03 MF **A01**
SACLANT ASW Research Centre, La Spezia (Italy).
Numerical Determination of Experimental Bottom Reflection Losses.
Technical rept.
O. F. Hastrup, and E. Schunk. 1 Dec 67, 27p
Rept no. SACLANTCEN-TR-104
Distribution Limitation now Removed.

Descriptors: *Underwater sound, Data processing systems, Reflection, Numerical analysis, Integra-

tion, Fourier analysis, Phase, Frequency, Analog-to-digital converters, Digital systems, Digital computers, Computer programs, Integral transforms, Italy.
Identifiers: Fourier transformation.

When analyzing bottom reflection data, the reflection coefficient is usually obtained by analogue band filtering, squaring, and integration. This method leads to a loss of information regarding both amplitude and phase. Another method is suggested using Fourier transforms giving the reflection coefficient as a continuous function of frequency. The analogue-recorded signal is then either directly converted to digital form or a graphical representation is converted to digital data by the use of an electronic digitizing table. The digital data so obtained can then be used as the input to the computer together with the programs for computing the reflection loss and phase angle. The results can be obtained either as a continuous function of frequency or in different frequency bands. (Author)

AD-830 061/CP PC **E03**/MF **A01**
Naval Ordnance Lab., White Oak, Md.
Approximation by Complete and Incomplete Sets of Harmonic Polynomials
Final rept.
T. E. Phipps, Jr, and A. Wrenn. 15 Dec 67, 46p
Rept no. NOLTR-67-170
Distribution Limitation now Removed.

Descriptors: *Differential equations, Integration, *Axial-flow compressor blades, Torsion, *Approximation(Mathematics), Polynomials, Numerical methods and procedures, Least squares method, Boundary value problems, Algorithms, Partial differential equations, Computer programs, Harmonic analysis, Interpolation.
Identifiers: *Dirichlet problem, Harmonic functions.

An empirical investigation is reported concerning approximate solution of the two-dimensional Dirichlet problem in a finite region R by linear combinations of harmonic polynomials selected from either complete or incomplete sets. The negative results of an earlier similar investigation of torsion problems by Poritsky and Danforth are traced to the collocation method they employed. An alternative method involving least squares fitting at boundary points in excess of the number required for collocation is found to yield more reliable results. An algorithm is given for the formal generation of complete sets of harmonic polynomials (of given maximum degree) from corresponding incomplete sets. (Author)

AD-835 518/CP PC **E03**/MF **A01**
Naval Postgraduate School, Monterey, Calif.
A Technique for Speeding Convergence in Solving Linear Programs
Master's thesis
John Edmund Easterbrook. Jun 68, 28p
Distribution Limitation now Removed.

Descriptors: *Linear programming, Convergence, *Programming(Computers), Problem solving, Iterative methods, Simplex method, Algorithms, Matrix algebra, Computer programs, Theses.
Identifiers: *Primal dual algorithm, FORTRAN 4 programming language, FORTRAN.

A technique for reducing the number of iterations necessary for solving linear programs using the primal-dual algorithm is presented. It appears that the new method will also decrease the number of iterations over any other simplex algorithm. A FORTRAN program incorporating the technique, as well as some comparative computational results are given. (Author)

AD-840 238/CP PC **E03**/MF **A01**
Naval Postgraduate School, Monterey, Calif.
A Branch and Exclude Algorithm for the Knapsack Problem
Master's thesis.
Jun 68, 28p
Distribution Limitations now Removed.

Descriptors: *Mathematical programming, Problem solving, Optimization, Combinatorial analysis, Flow charting, Computer programs, Algorithms, Theses.
Identifiers: *Knapsack problems, Integer programming.

A branch and exclude algorithm for the solution of the 'knapsack problem', max Summation from i = 1 to i = N of (v sub i) (x sub i) where Summation from i = 1 to i = N of (w sub i) (x sub i) = or < W) and x sub i = 0,1 is presented which requires relatively small amounts of computer running time and core storage allocation. In addition, a branch and bound scheme is developed. The branch and exclude method is then compared to the branch and bound method and to a branch and bound method given by Kolesar (2). Computational results are given. (Author)

AD-847 877/CP PC **E03**/MF **A01**
Naval Ordnance Lab., White Oak, Md.
A Method for Determining the Parameters of Ordinary Differential Equations
Charles E. Knadler, Jr. 5 Nov 68, 35p Rept no. NOLTR-68-192
Distribution Limitation now Removed.

Descriptors: *Differential equations, *Numerical methods and procedures, Partial differential equations, Approximation(Mathematics), Least squares method, Iterative methods, Integration, Computer programs.
Identifiers: DIFRED computer program, Runge-Kutta method, Ordinary differential equations.

The report presents a method for determining the parameters of ordinary differential equations, where it is not necessary that the equation have a closed-form solution. DIFRED, a computer data-reduction program utilizing the method, is also described. The program is written for an IBM 7090 computer operating under the IBSYS monitor. The mathematical formulation of the method is presented, and the FORTRAN listing of DIFRED and instructions for its use are included. (Author)

AD-863 321/CP HC A03 MF **A01**
SACLANT ASW Research Centre, La Spezia (Italy).
On the Digital Computer Simulation of a Tactical Game.
Technical memo.
B. W. Conolly. 1 Dec 64, 38p Rept no. SACLANTCEN-TM-88
Distribution Limitation now Removed.

Descriptors: *War games, Simulation, *Pseudo random systems, War games, Military strategy, Programming(Computers), Miss distance, Ranges(Distance), Simulation, Italy.
Identifiers: Algol programming language, Computerized simulation.

The report describes a game between two players P and S. P is a penetrator who has to cross a line AB of restricted length, patrolled by a searcher S. S obtains accurate information about the position of P at either random or regular intervals or continuously, and on the basis of this information attempts to place himself on AB in such a manner as to maximize his chance of intercepting P. P, on the other hand, is unaware of the location of AB, though he can be assumed to realize that A barrier threatens the achievement of his objective, and to maneuver in such a way as to minimize his chance of being intercepted. (Author)

AD-865 390/CP PC **E03**/MF **A01**
Army Missile Command, Redstone Arsenal, Ala. Advanced Sensors Directorate.
A Method of Fitting a General Equation to a Set of Data Values
Willaim R. Anderson. 20 Jan 70, 27p Rept no. RE-TN-70-2
Distribution Limitation now Removed.

Descriptors: *Functions, *Approximation(Mathematics), *Curve fitting, Computer programs, Experimental data, Least squares method, Taylor's series, Analytic functions, Algorithms.

The report describes a general purpose for fitting a general function to a set of data points. The function is approximated as a first-order Taylor's series expansion and the variable parameters are solved by using the least squares criteria. Included in the report is the description of a computer program which will perform the mechanics of the curve-fitting procedure. (Author)

AD-879 589/CP PC **A03** MF **A01**
SACLANT ASW Research Centre, La Spezia (Italy).
Numerical Solution of a System of Lanchester Differential Equations
Technical memo.
Svein Haugberg. 1 Dec 70, 41p Rept no. SACLANTCEN-TM-159
Distribution Limitation now Removed.

Descriptors: *Lanchester equations, Integration, *Computer programs, Lanchester equations, Algorithms, Numerical methods and procedures, Differential equations, Accuracy, Programming languages, Italy.
Identifiers: Algol Runge-Kutta-Merson method, Numerical integration.

Using the Runge-Kutta-Merson method a computer program was developed for the numerical solution of a system of generalized lanchester equations. A detailed description is given to the input-output features of the computer program and of the algorithm used to solve the equations. Two sample problems illustrate the use of the program and its flexibility. (Author)

AD-883 260/2CP PC **A02**/MF **A01**
Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.
A Computer Program for Calculating the Shape Parameters of Beta Distributions
Grady L. Jacobs. Mar 71, 21p Rept no. SLTR-11-71
Distribution limitation now removed.

Descriptors: *Distribution functions, *Computer programs, Programming languages, Problem solving, Costs, Monte Carlo method, Uncertainty, Decision making.
Identifiers: *Beta density functions, FORTRAN, FORTRAN 4 programming language, Heuristic computer program, PERT.

One of the problems in using Beta distributions in analysis of uncertainty is the inability to specify the shape parameters directly. This has resulted in various compromise techniques such as constraining the available distributions to nine basic types. This paper provides a methodology for calculating Beta distribution shape parameters based on estimates of the low, modal and high values, and the standard deviation. A FORTRAN 4 program for accomplishing the calculating is provided. The problem of defining heuristics for estimating the standard deviation is discussed and related to the normal distribution and PERT assumptions.

AECL-3784 PC **A03** MF **A01**
Atomic Energy Of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
Gausfit- a Fortran Program for Fitting Gaussian Functions
P. Y. Wong. Dec 70, 42p
U. S. Sales only

Descriptors: *Computer programs.

For abstract, see NSA 25 09, number 20846.

AECL-4210 PC **E03**/MF **A01**
Atomic Energy of Canada LTD., Chalk River (Ontario). Chalk River Nuclear Labs.
Remes 2: A Fortran Program to Calculate Rational Minimax Approximations to a Given Function
J. H. Johnson, and J. M. Blair. May 73, 85p
U.S. Sales Only.

Descriptors: *Functions, *Errors, *Computer codes, *R codes, Algorithms, Fortran.
Identifiers: AEC.

For abstract, see NSA 28 08, number 20562.

AECL-4311 PC **A03**/MF **A01**
Atomic Energy of Canada LTD., Chalk River (Ontario). Chalk River Nuclear Labs.
Forsim: A Fortran Oriented Simulation Package for the Transient Solution of Simultaneous Ordinary Differential Equations
M. B. Carver. Feb 73, 49p
U.S. Sales Only.

Descriptors: *Differential equations, Computer codes, *Computer codes, *F codes, Fortran, Numerical solution.
Identifiers: AEC.

For abstract, see NSA 28 02, number 04972.

AECL-4608 PC **A03**/MF **A01**
Atomic Energy of Canada LTD., Chalk River, Ontario. Chalk River Nuclear Labs.
Forsim: A Fortran-Oriented Simulation Package for the Automated Solution of Partial and Ordinary Differential Equation Systems
M. B. Carver. Nov 73, 35p
U.S. Sales Only.

Descriptors: *Computer codes, *F codes, *Differential equations, Computer codes, Errors, Fortran, Integrals, Time dependence.
Identifiers: AEC.

For abstract, see NSA 29 07, number 17961.

AECL-4832 PC **A03**/MF **A01**
Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.
Chebinq: A Fortran Program to Calculate Chebyshev Inequalities and Gaussian Integration Parameters.
K. B. Winterbon. Jul 74, 44p
U.S. Sales Only.

Descriptors: *Computer codes, *C codes, *Gauss function, *Numerical solution, Bibliographies, Cdc computers, Distribution functions, Fortran, Mathematics, Probability, Quadratures.

For abstract, see NSA 31 03, number 07986.

AECL-4844 PC **A05**/MF **A01**
Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.
Forsim: A Fortran Package for the Automated Solution of Coupled Partial and/or Ordinary Differential Equation Systems, User'S Manual.
M. B. Carver. Nov 74, 97p
U.S. Sales Only.

Descriptors: *Computer codes, *F codes, *Differential equations, Computer codes, Algorithms, Automation, Fortran, Manuals, Numerical solution, Programming.
Identifiers: ERDA/990200.

The FORSIM program is a versatile package that automates the solution of ordinary and partial differential equations or coupled differential equation systems. The philosophy of the program is to provide a tool which will solve a system of differential equations for a user, who need not be well versed in numerical analysis, but has some knowledge of FORTRAN. The equations to be solved, together with the initial conditions and any special instructions, may be specified by the user in a single FORTRAN subroutine, although he may write a number of routines if this is more suitable. These are then loaded with the control routines, which perform the solution and any requested input and output. Partial differential equations are automatically converted into sets of coupled ordinary differential equations by variable order discretization in the spatial dimension. These and other ordinary differential equations are integrated continuously in time using variable order, variable step, error-controlled algorithms. The mathematical routines are supplemented by flexible input/output facilities and a number of utility routines commonly used in simulation.

AECL-5262 PC **A02**/MF **A01**
Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.
Trend: A Program Using Cumulative Sum Methods to Detect Long-Term Trends in Data.
R. J. Cranston, R. M. Dunbar, and R. G. Jarvis.
Jan 76, 21p
U.S. Sales Only.

Descriptors: *Computer codes, *Data analysis, Cdc computers, Data processing, Fortran, T codes.
Identifiers: ERDA/990200, Canada, *TREND computer program, *Statistical analysis.

TREND is a computer program, in FORTRAN, to investigate data for long-term trends that are masked by short-term statistical fluctuations. To do this, it calculates and plots the cumulative sum of deviations from a chosen mean. As a further aid to diagnosis, the procedure can be repeated with a summation of the cumulative sum itself. 5 figures. (ERA citation 01:015356)

AEEW-M-1245 PC **A02**/MF **A01**
UKAEA Reactor Group, Winfrith. Atomic Energy Establishment.
Fodes: Technique for Solving First Order Differential Equations.
C. M. Street. Jan 74, 25p
U.S. Sales Only.

Descriptors: *Differential equations, *Numerical solution, *Computer codes, *F codes, Comparative evaluations, Digital computers, Forecasting, Programming languages.

For abstract, see NSA 30 09, number 26132.

AERE-R-7119 PC **A03**/MF **A01**
UKAEA Research Group, Harwell. Atomic Energy Research Establishment.
Two Fortran Subroutines for Direct Solution of Linear Equations Whose Matrix Is Sparse, Symmetric and Positive-Definite.
J. K. Reid. Jun 72, 34p
U.S. Sales Only.

Descriptors: *Computer codes, *M codes, *Differential equations, *Numerical solution, Comparative evaluations, Fortran, Matrices, Symmetry.

For abstract, see NSA 31 05, number 13453.

AERE-R-7470 PC **A03**/MF **A01**
Atomic Energy Research Establishment, Harwell (England).
Fortran Subroutine for Plotting a Cubic Spline Function
S. Marlow, and M. J. D. Powell. Jul 73, 29p
U.S. Sales Only.

Descriptors: *Polynomials, *Computer codes, Diagrams, Fortran.
Identifiers: AEC.

For abstract, see NSA 28 11, number 29442.

AERE-R-7986 PC **A04**/MF **A01**
UKAEA Research Group, Harwell. Atomic Energy Research Establishment.
Fortran Subroutines for Finding Polynomial Zeros.
K. Madsen, and J. K. Reid. Feb 75, 68p
U.S. Sales Only.

Descriptors: *Computer codes, *P codes, *Polynomials, *Numerical solution, Equations, Errors, Fortran, Ibm computers, Programming.
Identifiers: ERDA/990200.

Subroutines are presented for finding all the roots of a polynomial and bounds on their errors are presented. To find the zeros the algorithm of Madsen (1973) is used; to find error bounds the work of Peters and Wilkinson (1971) is used with some significant modifications. Both the real and complex cases are treated.

ANL-AMD-TM-303 PC **A04**/MF **A01**
Argonne National Lab., Ill.
OCOPTR: A Derivative Free Fortran Implementation of Davidon's Optimally Conditioned Method
W. C. Davidon, and L. Nazareth. Aug 77, 59p
Contract W-31-109-ENG-38

Descriptors: *Computer codes, *Optimization, Algorithms, Fortran, IBM-computers, O codes.
Identifiers: ERDA/990200, OCOPTR computer program, *Davidon method, Unconstrained optimization.

A derivative-free implementation of Davidon's Optimally Conditioned Method for unconstrained optimization is described, and computational experience on a set of test problems is given. 3 tables. (ERA citation 03:009489)

ANL-AMD-TM-305 PC **A03**/MF **A01**
Argonne National Lab., Ill.
MINKIT: An Optimization System
L. Nazareth. May 77, 26p
Contract W-7405-ENG-38

Descriptors: *Optimization, Algorithms, Least square fit, Nonlinear problems, Programming.
Identifiers: ERDA/990200, MINKIT computer program.

A set of ideas which have to do with organizing and developing optimization algorithms and software is described. These ideas are embodied in an optimization system (called Minkit) currently being developed by the author. Minkit is a collection of driver algorithms, modules, and testing aids for general unconstrained optimization, nonlinear least squares, and the solution of systems of nonlinear equations. The software, as it now stands, has been written primarily to aid the author in his research in optimization and is not intended for general distribution. The ideas underlying Minkit may, however, be of more general interest. A brief review of the design and current status of development of Minkit is given. 1 figure, 1 table. (ERA citation 02:061821)

ANL-AMD-TM-306 PC **A03**/MF **A01**
Argonne National Lab., Ill.
DRVOCR: A Fortran Implementation of Davidon's Optimally Conditioned Method
W. C. Davidson, and L. Nazareth. Aug 77, 37p
Contract W-31-109-ENG-38

Descriptors: *Computer codes, *Optimization, Algorithms, D codes, Fortran.
Identifiers: ERDA/990200, DRVOCR computer program, *Davidon method.

An implementation of Davidon's Optimally Conditioned Method which requires that both the function and its gradient be supplied is discussed. Computational experience on a set of test problems is also described. 3 tables. (ERA citation 03:009490)

ANL-AMD-TM-311 PC **A03**/MF **A01**
Argonne National Lab., Ill.
LINPACK Working Note No. 8: Three Numerical Experiments with Gaussian Elimination
J. T. Goodman, and C. B. Moler. Jul 77, 47p
Contract W-31-109-ENG-38

Descriptors: *Computer codes, *Matrices, Calculation methods, Errors, L codes, Limiting values.
Identifiers: ERDA/990200, *LINPACK computer program.

Three relatively brief papers are presented on the following subjects: element growth in Gaussian elimination, estimating cond(A) with subroutine DGECO, and consideration of an error bound in Gaussian elimination. (ERA citation 03:013571)

ANL-AMD-TM-313 PC **A10**/MF **A01**
Argonne National Lab., Ill.
LINPACK Working Note No. 9: Preliminary LINPACK User's Guide
J. J. Dongarra, J. R. Bunch, C. B. Moler, and G. W. Stewart. Aug 77, 216p

Contract W-31-109-ENG-38

Descriptors: *Matrices, *Computer codes, C codes, D codes, Fortran, L codes, Least square fit, Manuals, S codes, Z codes.
Identifiers: ERDA/990200, *LINPACK computer program.

LINPACK is a collection of Fortran programs for solving various types of linear systems. The package is concerned with general, banded, symmetric indefinite, symmetric positive definite, triangular and tridiagonal square matrices, as well as with least-squares problems and the QR and singular value decompositions of rectangular matrices. The routines are designed to be completely machine independent, fully portable, and to run at near optimum efficiency in most operating environments. (ERA citation 03:013572)

ANL-76-20 PC **A07**/MF **A01**
Argonne National Lab., Ill.
Simulation Test Approach to the Evaluation and Comparison of Unconstrained Nonlinear Optimization Algorithms
K. E. Hillstrom. Feb 76, 136p

Descriptors: *Algorithms, *Computer calculations, *Optimization, Comparative evaluations, Nonlinear problems, Simulation.
Identifiers: ERDA/990200, *Unconstrained optimization.

A simulation test technique was developed to evaluate and compare unconstrained nonlinear optimization computer algorithms. Descriptions of the test technique, test problems, computer algorithms tested, and test results are provided. (ERA citation 01:022334)

ANL-7628 HC A04 MF **A01**
Argonne National Lab., Ill.
Symbolic Derivative-Taker for a Special-Purpose Language for Least-Squares Fits.
Marian Gabriel. Feb 70, 72p
Contract W-31-109-eng-38

Descriptors: *Differential equations, Computer programs, *Programming languages, Curve fitting, FORTRAN, Least squares method.
Identifiers: DERV computer program.

For abstract, see NSA 2417

ANL-7660 HC A03 MF **A01**
Argonne National Lab., Ill.
C:Regn: A Reentrant Linear and Quadratic Regression Routine.
Conrad E. Thalmayer. Jan 70, 27p
Contract W-31-109-eng-38

Descriptors: *Regression analysis, Computer programs, *Curve fitting, Least squares method, Analysis of variance, Statistical data.
Identifiers: C:REGN computer program.

For abstract, see NSA 2414

ANL-7667 HC A02 MF **A01**
Argonne National Lab., Ill.
C:Reguse: A Linear and Quadratic Regression User Program.
Conrad E. Thalmayer. Feb 70, 19p
Contract W-31-109-eng-38

Descriptors: *Regression analysis, Computer programs, Statistical data, Least squares method, Curve fitting.
Identifiers: C:REGUSE computer program.

For abstract, see NSA 2414

ANL-77-XX-73 PC **A08**/MF **A01**
Argonne National Lab., Ill.
Updating the Symmetric Indefinite Factorization with Applications in a Modified Newton's Method
D. C. Sorensen. 1977, 155p
Contract W-31-109-ENG-38
Thesis.

Descriptors: *Computer codes, *Matrices, *Optimization, Accuracy, Algebra, Algorithms, Errors, Factorization, Fortran, Functionals, IBM computers, Iterative methods, Newton method, Nonlinear problems, Numerical analysis, S codes.
Identifiers: ERDA/990200, Newton method.

In recent years the use of quasi-Newton methods in optimization algorithms has inspired much of the research in an area of numerical linear algebra called updating matrix factorizations. Previous research in this area has been concerned with updating the factorization of a symmetric positive definite matrix. Here, a numerical algorithm is presented for updating the Symmetric Indefinite Factorization of Bunch and Parlett. The algorithm requires only O(n exp 2) arithmetic operations to update the factorization of a symmetric matrix when modified by a rank-one matrix. An error analysis of this algorithm is given. Computational results are presented that investigate the timing and accuracy of this algorithm. Another algorithm is presented for the unconstrained minimization of a nonlinear functional. The algorithm is a modification of Newton's method. At points where the Hessian is indefinite the search for the next iterate is conducted along a quadratic curve in the plane spanned by a direction of negative curvature and a gradient related descent direction. The stopping criteria for this search takes into account the second-order derivative information. The result is that the iterates are shown to converge globally to a critical point at which the Hessian is positively semidefinite. Computational results are presented which indicate that the method is promising. 4 figures, 9 tables. (ERA citation 02:055529)

ANL-77-12 PC **A12**/MF **A01**
Argonne National Lab., Ill.
DISPL: A Software Package for One and Two Spatially Dimensioned Kinetics-Diffusion Problems
G. K. Leaf, M. Minkoff, G. D. Byrne, D. Sorensen, and T. Bleakney. May 77, 272p
Contract W-31-109-ENG-38

Descriptors: *Computer codes, *Nonlinear Differential equations, Chemical reaction kinetics, Heat transfer, Water hammer, Bubbles, Cartesian coordinates, Cylindrical configuration, D codes, Diffusion, Enhanced recovery, Fortran, Ibm computers, Nonlinear problems, Numerical solution, One-dimensional calculations, Spherical configuration, Two-dimensional calculations.
Identifiers: ERDA/990200, ERDA/400000, ERDA/657006, Parabolic differential equations, Elliptic differential equations, Hyperbolic differential equations, DISPL computer program.

DISPL is a software package for solving some second-order nonlinear systems of partial differential equations including parabolic, elliptic, hyperbolic, and some mixed types such as parabolic--elliptic equations. Fairly general nonlinear boundary conditions are allowed as well as interface conditions for problems in an inhomogeneous medium. The spatial domain is one- or two-dimensional with Cartesian, cylindrical, or spherical (in one dimension only) geometry. The numerical method is based on the use of Galerkin's procedure combined with the use of B-splines in order to reduce the system of PDE's to a system of ODE's. The latter system is then solved with a sophisticated ODE software package. Software features include extensive dump/restart facilities, free format input, moderate printed output capability, dynamic storage allocation, and three graphics packages. 16 figures, 10 tables. (ERA citation 02:061818)

ANL-77-19 PC **A07**/MF **A01**
Argonne National Lab., Ill.
Comparative Test Results for Two ODE Solvers: EPISODE and GEAR
G. D. Byrne, A. C. Hindmarsh, K. R. Jackson, and H. G. Brown. Mar 77, 141p
Contract W-31-109-ENG-38

Descriptors: *Computer codes, *Differential equations, Chemical reaction kinetics, Comparative evaluations, E codes, Eigenvalues, G codes, Nonlinear problems, Numerical solution.
Identifiers: ERDA/990200, EPISODE computer program, GEAR computer program.

This is a sequel to the paper "A comparison of two ODE codes: GEAR and EPISODE," and is concerned with the testing of two superficially similar ODE packages, GEAR and EPISODE. Fourteen basic test problems, some with several cases, are the basis for the testing. These problems represent several types--nonlinear systems with real and complex eigenvalues, linear systems with varied diagonal dominance, linear scalar problems, stiff and nonstiff problems, chemical kinetics with and without diurnal effect, and systems arising from the use of the numerical method of lines. Some problems are included in order to examine the options and error returns. The test results are presented in two forms: raw output and a comparative display of operation counts and of timings for the best method in the GEAR package and the best method in the EPISODE package. This approach allows a comparison of the consequences of the fixed-step interpolate strategy (GEAR) for changing step size against the truly variable step size strategy (EPISODE). It is concluded that EPISODE is generally faster than GEAR for problems involving wave fronts or transients on the interior of the interval of integration. For linear or simply decaying problems, these roles are usually reversed. 19 figures, 116 tables. (ERA citation 02:047025)

ANL-77-49 PC **A08**/MF **A01**
Argonne National Lab., Ill.
Updating the Symmetric Indefinite Factorization with Applications in a Modified Newton's Method
D. C. Sorensen. Jun 77, 156p
Contract W-31-109-ENG-38
Thesis.

Descriptors: *Computer codes, *Matrices, *Optimization, Algebra, Algorithms, Computer calculations, Factorization, Functionals, Nonlinear problems, P codes, S codes.
Identifiers: ERDA/990200, Newton method.

In recent years the use of quasi-Newton methods in optimization algorithms has inspired much of the research in an area of numerical linear algebra called updating matrix factorizations. Previous research in this area has been concerned with updating the factorization of a symmetric positive definite matrix. Here, a numerical algorithm is presented for updating the Symmetric Indefinite Factorization of Bunch and Parlett. The algorithm requires only O(n exp 2) arithmetic operations to update the factorization of an n x n symmetric matrix when modified by a rank-one matrix. An error analysis of this algorithm is given. Computational results are presented that investigate the timing and accuracy of this algorithm. Another algorithm is presented for the unconstrained minimization of a nonlinear functional. The algorithm is a modification of Newton's method. At points where the Hessian is indefinite the search for the next iterate is conducted along a quadratic curve in the plane spanned by a direction of negative curvature and a gradient-related descent direction. The stopping criteria for this search take into account the second-order derivative information. The result is that the iterates are shown to converge globally to a critical point at which the Hessian is positive semidefinite. Computational results are presented which indicate that the method is promising. 6 figures, 9 tables. (ERA citation 02:055528)

ANL-7898 PC **A07**/MF **A01**
Argonne National Lab., Ill.
Multistep Elimination over Commutative Rings
Erwin H. Bareiss, and Donald Mazukelli. Apr 72, 137p
Contract W-31-109-ENG-38

Descriptors: *Computer programs, *Mathematics, *Matrices MATHEMATICS.

For abstract, see NSA 26 18, number 45058.

ANL-7907 PC **A04**/MF **A01**
Argonne National Lab., Ill.
Fast Fourier Transform Using the Pdp-11
L. R. Windmiller, J. B. Ketterson, and J. C. Shaw. Jun 72, 73p
Contract W-31-109-ENG-38

Descriptors: *Computer programs.

For abstract, see NSA 26 18, number 45059.

BDX-613-117 HC A02 MF **A01**
Bendix Corp., Kansas City, Mo.
Solutions for the Wagr Sequential T-Test, Sequential Variables Sampling Plans to Control the Percent Defective.
R. L. Kirkpatrick. Jun 69, 22p
Contract AT(29-1)-613

Descriptors: *Quality control, *Statistical tests, *Sampling, Sequential analysis, Reliability, Computer programs.
Identifiers: *WAGR sequential t test, *T test.

For abstract, see NSA 2413

BDX-613-813 PC **A03**/MF **A01**
Bendix Corp., Kansas City, Mo.
Nonlin: A Computer Program for Least Squares Estimation of Nonlinear Parameters and Applications
B. J. Neal. Dec 72, 40p
Contract AT(29-1)-613

Descriptors: *Computer codes, *N codes, *Nonlinear problems, Computer codes, *Least square fit, Computer codes.
Identifiers: AEC.

For abstract, see NSA 28 01, number 01969.

CIC-C-2.2-001 PC **A02**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.
Polynomial Root Finder.
J. D. Lawrence. 16 Dec 66, 21p

Descriptors: *Computer codes, *M codes, Computer calculations, Fortran, Numerical solution, Polynomials.

For abstract, see NSA 31 03, number 07992.

CIC-D-1.2-001 PC **A03**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.
Romberg Integration.
F. N. Fritsch. 25 May 67, 31p

Descriptors: *Computer codes, *R codes, *Integrals, *Numerical solution, Algorithms, Fortran, Ibm computers.
Identifiers: ERDA/990200, Romberg algorithm.

The Romberg algorithm provides a fast and accurate method for numerically approximating the definite integral of the function f(x) from a to b where a FORTRAN function is available for calculating the integrand. Implementation of the algorithm in several machines is explained, and FORTRAN listings of several versions are given. It should be noted that the coding is rather dated, as the report was issued in 1967. 1 figure, 5 tables.

CISE-N-175 PC **A03**/MF **A01**
Centro Informazioni Studi Esperienze, Milan (Italy).
Computational Experience with Quasi-Newton Algorithms for Minimization Problems of Moderately Large Size.
E. Spedicato. Oct 75, 38p
U.S. Sales Only.

Descriptors: *Algorithms, Computer calculations, Computer codes, Fortran, Functions, Ibm computers, Nonlinear problems.
Identifiers: ERDA/990200, *Optimization, Italy.

Two quasi-Newton algorithms, known as the BFS and the OS method, for the unconstrained minimization of nonlinear functions are compared on a set of significant problems up to 80 variables. It is shown that, when the minimization is started with the unit matrix, the performance of the BFS deteriorates with growing n more rapidly than the performance of the OS. A way to scale the initial matrix in some cases is also suggested; this results in greatly improving the performance of the BFS, which becomes competitive with the OS even for large problems. 10 tables.

COM-71-00616/CP PC **A04** MF **A01**
National Weather Service, Silver Spring, Md. Office of Hydrology.
Direct Search Optimization in Mathematical Modeling and a Watershed Model Application
Technical memo.
John C. Monroe. Apr 71, 59p Rept no. NOAA-TM-NWS-HYDRO-12

Descriptors: *Mathematical models, Computerized simulation, *Watersheds, Mathematical models, Optimization, Input-output routines, Least squares method, Hydrologic cycles, Computer programs, Search theory.

There has been an increasing need for the objective determination of an optimal set of coefficients for conceptual models. This report describes and demonstrates the application of Pattern Search, a direct search optimization technique, to mathematical modeling. The technique is applied to a Watershed Model. It is shown that Pattern Search is a powerful technique for the objective determination of optimal values for model coefficients. (Author)

COM-73-10049/CP PC **A03**/MF **A01**
National Oceanic and Atmospheric Administration, Boulder, Colo. Office of Research Support Services.
MANIP: A Computer System for Algebra and Analytic Differentiation
Technical memo.
Bernice Bender. Nov 72, 32p NOAA-TM-ERL-ORSS-6, NOAA-72111403

Descriptors: *Computer programming, Mathematical programming, FORTRAN, Differential calculus, Numerical analysis, Mathematical logic, Programming manuals, Algebra.
Identifiers: FORTRAN 4 programming language, CDC 3600 computers, MANIP system.

A mathematical expression writeen in FORTRAN is stored in the computer as a string of BCD characters. The algebra program operates exhaustively on the expression according to standard laws of algebra which have been translated into a complicated set of logical decision rules for manipulating character sequences. Similarly, the differentiation program finds partial and mixed partial derivatives of any order. Most numeric and algebraic operations are performed automatically. A number of pseudo instructions is available and provides additional flexibility. The FORTRAN 4 programs are written for the CDC 3400 computer. (Author)

COM-73-50257/CP PC-**GPO**/MF **A01**-NTIS
National Bureau of Standards, Washington, D.C. Inst. for Basic Standards.
A Users' Guide to the OMNITAB Command 'Statistical Analysis'
Technical note
H. H. Ku. Mar 73, 45p Rept no. NBS-TN-756
Paper copy available from GPO $0.75 as C13.46:756.

Descriptors: *Programming manuals, *Statistical analysis, Control sequences, Frequency distribution, Standard deviation.
Identifiers: OMNITAB 2 computer program, NBS.

The Technical Note is the first of a series of interpretive notes for a number of commands in the OMNITAB system that have the automatic printout feature. Others planned in the series include commands FIT and POLYFIT, TWOWAY analysis, ONEWAY analysis, and CORRELATION. These notes aim to be self-contained so that users may have sufficient information on hand for the understanding of the statistics computed and to use them for their immediate applications. Computation formulas are given in the text, and a number of statistical tables are reproduced in the Appendix for the convenience of users. (Author)

COM-73-50484/CP PC-**GPO**/MF **A01**-NTIS
National Bureau of Standards, Washington, D.C. Applied Mathematics Div.
A Performance Comparison of Labeling Algorithms for Calculating Shortest Path Trees
Technical note (Final)
Judith Gilsinn, and Chrostoph Witzgall. May 73, 91p Rept no. NBS-TN-772
Prepared in cooperation with Boeing Scientific Labs., Seattle, Wash.
Paper Copy available from GPO $1.25 as C13.46:772.

Descriptors: *Network flows, Algorithms, Trees(Mathematics), Transportation models, Telephone lines, Computer programs, FORTRAN.
Identifiers: Shortest path method, NBS.

Many applications in transportation and communication require the calculation of shortest routes between points in a network, and several algorithms for the solution of this problem exist in the literature. The paper examines one class of such algorithms, that which calculates a shortest route from one point in the network to all other intersection points. Computer data handling techniques which can be used to improve the two basic algorithms in this class are investigated. Results of computer timing runs on various types and sizes of networks are compared, and the differences, sometimes of an order of magnitude, are analyzed. Detailed flowcharts and computer programs of the tested algorithms are also included. (Author)

COM-73-50669-03-04/CP
PC-**GPO**/MF **A01**-NTIS
National Bureau of Standards, Washington, D.C.
Journal of Research of the National Bureau of Standards: B. Mathematical Sciences. Volume 77B, Numbers 3 and 4, July-December 1973
Quarterly rept.
Dec 73, 211p
Library of Congress Catalog Card no. 62-4414.
Paper copy available from GPO $9.00/year as C13.22/SecB:77, $2.25/copy as C13.22/SecB:77/3-4.

Descriptors: *Applications of mathematics, Continuum mechanics, Matrices(Mathematics), Bessel functions, Computer programs, FORTRAN, Probability density functions, Mathematical tables.
Identifiers: NBS.

Contents:
- An application of Schur's lemma on irreducible sets of matrices in continuum mechanics;
- Remarks on a problem of Rademacher in the theory of modular forms;
- The characterizations of (Aq(U));
- Character induced subgroups;
- Performance testing of a FORTRAN library of mathematical function routines-A case study in the application of testing techniques;
- Bessel functions I and J of complex argument and integer order;
- Certification of an algorithm for Bessel functions of real argument;
- Bessel functions of real argument and integer order;
- Certification of an algorithm for Bessel functions of complex argument;
- Triangles generated by powers of triplets on the unit circle;
- Tables and graphs of the stable probability density functions.

COM-74-10748/3CP PC **E06**/MF **A01**
RAND Corp., Santa Monica, Calif.
Univariate and Multivariate Log-Linear and Logistic Models
Marc Nerlov, and S. James Press. Dec 73, 143p
R-1306-EDA/NIH, EDA/OER-74-210
Grant EDA-OER-388-G-71-11

Descriptors: *Statistical inference, Analysis of variance, Regression analysis, Multivariate analysis, Covariance, Probability density functions, Computer programs, Theorems.
Identifiers: Logistic density functions, Maximum likelihood estimation, EDA.

The objective of the study is to make inferences about relationships which determine jointly dependent qualitative variables (i.e., variables that

are both categorical and unordered). The report consists of five sections and an appendix. Section 1 provides a general review of the single qualitative variable problem. Section 2 treats the dichotomous single qualitative variable. Section 3 discusses the polytomous single qualitative variable. Section 4 generalizes the known results for a single qualitative variable ('univariate') to some new results for several jointly dependent qualitative variables ('multivariate') and provides a general model for the analysis of covariance ('ANCOVA') for qualitative variables. Section 5 is devoted to empirical applications of the theory involving several socioeconomic problems. The empirical investigations presented in this report suggest several methodological conclusions, which may be applicable only to data sets with certain similar features.

COM-74-50458-03/CP PC-GPO/MF A01-NTIS
National Bureau of Standards, Washington, D.C.
Journal of Research of the National Bureau of Standards: B, Mathematical Sciences. Volume 78B, Number 3, July-Sept. 1974
Quarterly rept.
1974, 75p Rept no. NBS-JRB-78-3
See also Quarterly rept. no. 2, COM-74-50458-02. Paper copy available from GPO as C13.22/secB:78B(3).

Descriptors: *Mathematics, *Reviews, Matrices(Mathematics), Computation, Bessel functions, Integrals, Convex sets, Network flows, Computer programs.
Identifiers: Shortest path method.

Contents:
- A sufficient condition for matrix stability;
- Computation of the field of values of a 2 x 2 matrix;
- The factorization of a matrix as the commutator of two matrices;
- Complete elliptic integrals resulting from infinite integrals of Bessel functions;
- The convex hull of the transposition matrices;
- Computational experience with an algorithm for finding the k shortest paths in a network;
- How bad is the Hadamard determinantal bound;
- Publications of the National Bureau of Standards.

COM-74-50458-04/CP PC-GPO/MF A01-NTIS
National Bureau of Standards, Washington, D.C.
Journal of Research of the National Bureau of Standards: B: Mathematical Sciences, Volume 78B, Number 4, Oct-Dec 1974
Quarterly rept.
1974, 52p Rept no. NBS-JRB-78-4
Library of Congress Catalog Card no. 62-4414. See also Quarterly rept. no. 3, COM-74-50458-03. Paper copy available from GPO as C13.22/secB:78B(4).

Descriptors: *Mathematics, *Reviews, Matrices(Mathematics), Trees(Mathematics), Graph theory, Special functions, Exponential functions, Computer programs.

Contents:
- Saddlepoints in P-pivot classes of skew matrices;
- Maximizing the number of spanning trees in a graph with n nodes and m edges;
- The field of values and spectra of positive definite multiples;
- Automatic computing methods for special functions-part 2-the exponential integral (E sub n)(x).

COM-74-50762/5CP PC-GPO/MF A01-NTIS
National Bureau of Standards, Washington, D.C. Inst. for Basic Standards.
Designs for the Calibration of Small Groups of Standards in the Presence of Drift
Final rept.
Joseph M. Cameron, and Geraldine E. Hailes.
Aug 74, 36p Rept no. NBS-TN-844
Library of Congress Catalog Card no. 74-600133. Paper copy available from GPO $0.70.

Descriptors: *Experimental design, Block design, Calibrating, Temperature measurement, Polarimetry, Standards, Computer programs.
Identifiers: BASIC programming language.

The process of calibrating a small number of 'unknown' standards relative to one or two reference standards involved determining differences among the group of objects. Drift, due most often to temperature effects, or a 'left-right' polarity effect can bias both the values assigned to the objects and the estimate of the effect of random errors. This note presents schedules of measurements of differences that eliminate the bias from these sources in the assigned value and variances at the same time gives estimates of the magnitude of these extraneous components. The use of these designs in measurement process control is discussed and a computer program in BASIC is presented.

COM-75-10812/6CP PC A03/MF A01
Office of Telecommunications, Boulder, Colo. Inst. for Telecommunication Sciences.
A Method of Bivariate Interpolation and Smooth Surface Fitting Based on Local Procedures
Hiroshi Akima. Mar 73, 47p Rept no. OTR-73-7

Descriptors: *Curve fitting, *Interpolation, Polynomials, Geometric surfaces, Computation, Computer programs, FORTRAN.

A method is designed for interpolating values given at points of a rectangular grid in an x-y plane by a smooth bivariate function z=z(x,y). The interpolating function is a bicubic polynomial in each cell of the rectangular grid. Emphasis is on avoiding excessive undulation between given grid points.

COM-75-11285/4CP PC A04/MF A01
Office of Telecommunications, Boulder, Colo. Inst. for Telecommunications Sciences.
A Method of Bivariate Interpolation and Smooth Surface Fitting for Values Given at Irregularly Distributed Points
Hiroshi Akima. Aug 75, 56p Rept no. OTR-75-70

Descriptors: *Polynomials, *Interpolation, *Computer programs, Approximation, Tables(Data), FORTRAN.

A method of bivariate interpolation and smooth surface fitting is developed for z values given at points irregularly distributed in the x-y plane. The interpolating function is a fifth-degree polynomial in x and y defined in each triangular cell which has projections of three data points in the x-y plane as its vertexes. Each polynomial is determined by the given values of z and estimated values of partial derivatives at the vertexes of the triangle. Procedures for dividing the x-y plane into a number of triangles, for estimating partial derivatives at each data point, and for determining the polynomial in each triangle are described. A simple example of the application of the proposed method is shown. User information and FORTRAN listings are given on a computer subprogram package that implements the proposed method.

COM-75-11380/3CP PC A04/MF A01
National Bureau of Standards, Washington, D.C. Applied Mathematics Div.
The National Bureau of Standards' Linear and Quadratic Programming Subroutines
Final rept.
W. G. Hall, R. H. F. Jackson, and P. B. Saunders. Feb 72, 70p* Rept no. NBS-10695
See also report dated Feb 75, COM-75-11381.

Descriptors: *Linear programming, *Computer programs, Simplex method, Nonlinear programming, Subroutines, Algorithms.
Identifiers: *Quadratic programming, Kuhn-Tucker theorem, FORTRAN 5 programming language, RVSMPX computer program, SIMPLX computer program.

This report documents one phase of an effort to provide users, of the facility operated by the National Bureau of Standards' Computer Services Division, with reliable, well-tested, clearly-described solution algorithms for selected frequently-arising classes of special mathematical problems. The report presents algorithms for the simplex and revised simplex methods of linear programming, as well as their adaptations to quadratic programming. Set up as subroutines, the present versions of these codes use internal storage only, with resultant limitations on the size of the problems which can be treated.

COM-75-11381/1CP PC A03/MF A01
National Bureau of Standards, Washington, D.C. Applied Mathematics Div.
Post Optimality and Parametric Analysis with the National Bureau of Standards' Linear Programming Subroutine RVSMPX
Final rept.
Tyrone B. Ayers. Feb 75, 48p Rept no. NBSIR-75-666
See also report dated Feb 72, COM-75-11380.

Descriptors: *Linear programming, *Computer programs, Subroutines, Algorithms.
Identifiers: Parametric programming, *RVSMPX subroutine.

The present report presents subroutines which perform post-optimality analysis and parametric programming studies on linear programming problems solved by the National Bureau of Standards' RVSMPX subroutine. (The present versions of these codes use internal storage only.)

CONF-740703-1 PC A03/MF A01
Oak Ridge National Lab., Tenn.
Interactive Modeling of Ecosystems.
B. W. Rust, and J. B. Mankin. 1974, 27p

Descriptors: *Ecosystems, *Mathematical models, *Computer codes, *M codes.

For abstract, see NSA 30 03, number 06566.

CONF-7606140-1 Not available NTIS
Argonne National Lab., Ill.
Mathematical Software: Why the Fuss
W. J. Cody. 1976, 16p
Contract W-31-109-ENG-38
Siam national meeting, Chicago, Illinois, United States of America (USA), 18 Jun 1976.
Available from ERDA, P.O. Box 62, Oak Ridge, TN 37830, Attn: TIC.

Descriptors: *Algorithms, Computer codes, Errors, Optimization, Programming.
Identifiers: ERDA/990200, *Computer software.

John Rice introduced the term mathematical software in 1969 to denote "the set of algorithms in the area of mathematics." Starting with a meeting at Purdue University the following year, the subject of mathematical software has steadily gained in professional stature. An explanation for the lay scientist of "what the fuss is all about" is given. Mathematical software is characterized in the restricted sense of computer software implementing numerical algorithms, and some of the scientific endeavor spawned to support the development of such software is discussed. 50 references. (ERA citation 02:050497)

COO-1469-205 PC A02/MF A01
Illinois Univ., Urbana. Dept. Of Computer Science.
Operating Manual for Difmf3. A Program to Solve Initial Conditions in Simultaneous Differential Equations
Bill Van Melle. Apr 72, 23p Rept no. UIUCDCS-F-72-870
Contract AT(11-1)-1469

Descriptors: *Computer programs, *Differential equations.

For abstract, see NSA 26 18, number 45083.

COO-1469-212 PC **E05**/MF **A01**
Illinois Univ., Urbana. Dept. Of Computer Science.
Automatic Solutions of Partial Differential Equations
L. A. Larsen. Oct 72, 134p Rept no. UIUCDCS-R-72-546
Contract AT(11-1)-1469

Descriptors: *Differential equations, *Numerical solution, Automation, Computer codes.
Identifiers: AEC.

For abstract, see NSA 28 08, number 20569.

COO-1469-225 PC **A03**/MF **A01**
Illinois Univ., Urbana. Dept. Of Computer Science.
Documentation for Dfasub: A Program for the Solution of Simultaneous Implicit Differential and Nonlinear Equations
R. L. Brown, and C. W. Gear. Jul 73, 41p Rept no. UIUCDCS-R-73-575
Contract AT(11-1)-1469

Descriptors: *Differential equations, *Numerical solution, *Computer codes, *D codes, Nonlinear problems.
Identifiers: AEC.

For abstract, see NSA 28 10, number 26825.

COO-1469-226 PC **A03**/MF **A01**
Illinois Univ., Urbana (Usa). Dept. Of Computer Science.
Evaluation of an Integration Technique for the Solution of Nonlinear Equations
J. H. Robb. Aug 73, 37p Rept no. UIUCDCS-R-73-576
Contract AT(11-1)-1469

Descriptors: *Differential equations, *Numerical solution, *Algebra, *Equations, *Computer codes, *D codes, Mixing.
Identifiers: AEC.

For abstract, see NSA 29 03, number 07383.

COO-2200-4 PC **A02**/MF **A01**
Northwestern Univ., Evanston, Ill. (Usa).
Periodic Band Matrix Solution
W. P. Gibbons. 30 Sep 73, 9p
Contract AT(11-1)-2200

Descriptors: *Equations, *Analytical solution, *Computer codes, *B codes, *Matrices, Analytical solution.
Identifiers: AEC.

For abstract, see NSA 29 02, number 04697.

COO-2218-79 PC **A05**/MF **A01**
Illinois Univ. at Urbana Champaign.
Improved Monte Carlo Method for Evaluating Multidimensional Integrals
S. K. Yuen. 1977, 94p
Contract EY-76-S-02-2218
Thesis.

Descriptors: *Computer codes, *Integrals, Algorithms, Algol, Evaluation, Fortran, IBM computers, M codes, Monte Carlo method, PL-1 language.
Identifiers: ERDA/990200.

The goal of this work was to develop an improved Monte Carlo method and implement a computer code for performing automatic integration of multi-dimensional integrals of the form integral f(X)dX over a closed region in k-dimensional Euclidean space, where X is a point in the space and DX = dx sub 1 dx sub 2 ...dx/sub k/. The scheme is "automatic" in the sense that it returns a value for the integral when the user inserts the limits of the integral, a function subroutine for computing f(X), and a tolerance. A survey on currently known methods of multiple integration is given first, and the MCSS scheme of Halton and Zeidman is found to be the best one implemented as a computer program. Improvements were made to make the sequential stratification technique more powerful and efficient. The resulting MCSSAV algorithm is readily programable in Algol and PL/I. Because of its recursive feature, programing it in FORTRAN is less straightforward; a flowchart and listing are given for this language. For lower-dimensional integrals, the program achieves accuracies of 4 to 5 significant figures for small amounts of CPU time, e.g., 30 seconds on an IBM 360/75. Test results for higher-dimensional integrals are not very satisfactory due to the biased distribution of random samples in n-space simulated by the Lehmer pseudorandom number generator. Several related subroutines for sampling and making estimates are also listed. 6 figures, 2 tables. (ERA citation 02:061825)

COO-2280-24 PC **A02**/MF **A01**
Northwestern Univ., Evanston, Ill. Dept. of Computer Sciences.
TWO-STEP: User's Guide (Computer Program for CDC 6400)
E. H. Bareiss, and R. Kobbe. Apr 76, 16p
Contract E(11-1)-2280

Descriptors: *Computer codes, *Equations, *Matrices, Cdc computers, Fortran, Manuals, Numerical solution, T codes.
Identifiers: ERDA/990200, CDC-6400 computers, TWO STEP computer program.

A guide for the use of the CDC-6400 Computer Program TWO-STEP for the exact solution of linear matrix equations over the integral domain is given. The rational result is converted into decimal form to 12 decimal places. (ERA citation 01:026922)

COO-2280-29 PC **A03**/MF **A01**
Northwestern Univ., Evanston, Ill.
Two-Step, User's Guide. Solution of a Linear System of Equations Using the Exact Two-Step Method
R. Kobbe, E. H. Bareiss, and A. Antolak. Feb 77, 34p
Contract EY-76-S-02-2280

Descriptors: *Computer codes, *Matrices, Equations, Cdc computers, Numerical solution, T codes.
Identifiers: ERDA/990200, CDC-6400 computers, TWO-STEP computer program.

The use of the CDC-6400 Computer Program TWO-STEP for the exact solution of linear matrix equations over the integral domain is discussed. The rational result is given as output and also converted into decimal form to twenty decimal places. (ERA citation 03:007787)

COO-2383-0024 PC **A02**/MF **A01**
Illinois Univ., Urbana Dept. of Computer Science.
Numerical Errors in Sparse Linear Equations.
C. W. Gear. May 75, 8p
Contract AT(11-1)-2383

Descriptors: *Equations, *Errors, *Matrices, Computer codes, Data processing.
Identifiers: ERDA/990200.

Important classes of problems such as network analysis lead to very sparse unsymmetric systems of linear equations of a high order. Frequently a Gauss elimination technique is used to form the LU decomposition with some form of pivoting being done to reduce fill-in and to preserve some numerical stability. The purpose of this note is to show that an error bound can be obtained of the same size as that obtained when analyzing a p by p system, where p is the maximum number of nonzeros in rows or columns of the decomposed matrix.

COO-2383-0025 PC **A03**/MF **A01**
Illinois Univ., Urbana Dept. of Computer Science.
Automatic Integration of the Heat Equation.
M. H. Ostrar. Oct 75, 31p Rept no. UIUCDCS-R-75-754
Contract AT(11-1)-2383

Descriptors: *Differential equations, *Finite difference method, Computer codes, Fortran, Numerical solution.
Identifiers: ERDA/990200, *Heat equation, *Numerical integration.

A scheme for automatically integrating the heat equation is discussed. A program based on this scheme is explained, and the results of integrating the heat equation for a number of different initial conditions are presented and interpreted.

COO-2383-0030 PC **A04**/MF **A01**
Illinois Univ., Urbana. Dept. of Computer Science.
Blended Linear Multistep Methods
R. D. Skeel, and A. K. Kong. Jun 76, 73p Rept no. UIUCDCS-R-76-800
Contract AT(11-1)-2383

Descriptors: *Computer codes, *Differential equations, Accuracy, Algorithms, B codes, D codes, Fortran, Numerical solution.
Identifiers: ERDA/990200, *Multistep Methods.

The accuracy of linear multistep formulas suitable for stiff differential systems is limited. Greater accuracy can be attained by including higher derivatives in the formula, but this is not practical for all problems. It is possible, however, to duplicate the absolute stability region for any given m-derivative multistep formula by taking a linear combination of m multistep formulas. These blended formulas are similar to Lambert and Sigurdsson's linear multistep formulas with variable matrix coefficients, but the approach is different. Implementation details and numerical results are presented for a variable-order, variable-step blend of the Adams--Moulton and the backward differentiation formulas. 7 tables. (ERA citation 02:004345)

COO-2383-0032 PC **A06**/MF **A01**
Illinois Univ., Urbana. Dept. of Computer Science.
Numerical Solution of Stiff Ordinary Differential Equations Using Collocation Methods
B. D. Link. Jun 76, 113p Rept no. UIUCDCS-R-76-813
Contract E(11-1)-2383
Thesis.

Descriptors: *Differential equations, Computer codes, Numerical solution, Quadratures.
Identifiers: ERDA/990200, *Collocation method.

A new class of methods, collocation methods, is suitable for the integration of stiff ordinary differential equations. The order and stability regions of these methods are characterized. The methods are stable and convergent for infrequent formula changes and small stepsize changes. Block multistep methods which are stiffly stable up to order 24 and several families of multistep methods stiffly stable up to order 9 exist. A similar class of quadrature methods includes a family with the same stability regions as Enright's second derivative methods but only requires first derivatives. (ERA citation 02:008873)

COO/2895-6 PC **A03**/MF **A01**
Carnegie-Mellon Univ., Pittsburgh, Pa.
Simplified Algorithm to Solve Geometric Programming Problems Using Fortran
M. Lepley. 1 Oct 76, 40p
Contract EY-76-S-02-2895

Descriptors: *Computer codes, *Ocean thermal power plants, Computer calculations, Design, Fortran, Mathematical models, Optimization, Programming.
Identifiers: ERDA/140800., *Geomtric programming.

Geometric Programming has proven to be a useful tool for the optimum design of solar sea power plants. The Carnegie Mellon University team working on the OTEC concept has found it profitable to develop a FORTRAN based computer code to solve simple geometric programs which arise often in OTEC work. This report describes such a program and gives an outline of how the computer program can be used in general. (ERA citation 02:054123)

COO-3077-139 PC **A06**/MF **A01**
New York Univ., N.Y. Courant Inst. of Mathematical Sciences.

Method of Lines Solution of Partial Differential Equations
J. M. Hyman. Oct 76, 113p
Contract EY-76-C-02-3077

Descriptors: *Computer codes, *Differential equations, Fortran, M codes, Numerical solution.
Identifiers: ERDA/990200, *Partial differential equations, Computation, Numerical integration.

An analysis is given of effective strategies for the so-called method of lines solution of the initial boundary-value problem for partial differential equations of the form u/sub t/ = g(x,t,u,u/sub x/ ,u/sub xx/,f/sub x/), where f = f*x,t,u,u/sub x/,u/ sub xx/). Also described is a user-oriented FORTRAN subroutine package called MOL1D for the numerical solution of equations of this type using the method of lines. 5 figures, 10 tables. (ERA citation 02:031723)

COO-3077-99 PC **A06**/MF **A01**
New York Univ., N.Y. Courant Inst. of Mathematical Sciences.
Numerical Solution of Helmholtz'S Equation by the Capacitance Matrix Method.
O. Widlund, and W. Proskurowski. Nov 75, 104p
Contract E(11-1)3077

Descriptors: *Differential equations, *Numerical solution, Computer calculations, Computer codes, Dirichlet problem, Finite difference method, Fortran, Ibm computers, Matrices, Poisson equation.
Identifiers: ERDA/990200, *Helmholtz equation.

The computer solution of the Helmholtz equation is discussed. Problems can be treated on bounded regions which do not allow for separation of variables. The topics treated in the report are as follows: certain results from classical potential theory, the imbedding of discrete Poisson problems, a capacitance matrix method for the Dirichlet case, a capacitance matrix method for the Neumann case, the Fourier--Toeplitz method and the fast generation of the capacitance matrix, the conjugate gradient method, previous work on capacitance matrix methods, numeral experiments, and outline of a computer program for the numerical solution of the interior Helmholtz equation in two variables with the Dirichlet and Neumann boundary conditions by finite difference methods. 3 figures, 8 tables.

CTC-39 PC **A20** MF **A01**
Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center.
Computing Technology Center Numerical Analysis Library.
G. W. Westley, and J. A. Watts. 5 Oct 70, 462p
Contract W-7405-ENG-26

Descriptors: *Computer programs.

For abstract, see NSA 24 24, number 53038.

CTC-54 PC **A03**/MF **A01**
Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center.
Spline-in-Tension with Unequal Spacing of Intervals
T. E. Pritchard. 7 Jun 72, 43p
Contract W-7405-ENG-26

Descriptors: *Computer programs, *Spline functions.

For abstract, see NSA 26 17, number 42663.

EUR-4959 PC **A04**/MF **A01**
European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center.
Algorithm for Nonlinear Data Fit by the Least Squares Method
E. van der Voort, and J. P. Halleux. Apr 73, 64p
U.S. Sales Only.

Descriptors: *Nonlinear problems, *Algorithms, *Computer codes, *D codes, Iterative methods, Least square fit, Mathematical models, Statistics.
Identifiers: AEC.

For abstract, see NSA 28 03, number 07632.

GA-A-14055 PC **A04**
General Atomic Co., San Diego, Calif.
STADIC: A Computer Code for Combining Probability Distributions
J. J. Cairns, and K. N. Fleming. Mar 77, 67p
Contract EY-76-C-03-0167-PRJ-51

Descriptors: *Computer codes, Htgr type reactors, Reactor accidents, Monte carlo method, Probability, Reactor safety, S codes.
Identifiers: ERDA/210300, ERDA/220900, *STADIC computer program, *Probability distribution functions, Statistical analysis.

The STADIC computer code uses a Monte Carlo simulation technique for combining probability distributions. The specific function for combination of the input distribution is defined by the user by introducing the appropriate FORTRAN statements to the appropriate subroutine. The code generates a Monte Carlo sampling from each of the input distributions and combines these according to the user-supplied function to provide, in essence, a random sampling of the combined distribution. When the desired number of samples is obtained, the output routine calculates the mean, standard deviation, and confidence limits for the resultant distribution. This method of combining probability distributions is particularly useful in cases where analytical approaches are either too difficult or undefined. (ERA citation 02:048435)

HEDL-TME-75-45 PC **A03**/MF **A01**
Hanford Engineering Development Lab., Richland, Wash.
HDES5: A Subroutine to Solve a System of Differential Equations.
B. C. Gneiting, and F. E. Bard. May 75, 28p
Contract AT(45-1)-2170

Descriptors: *Differential equations, *Numerical solution, *Computer codes, *H codes, Cdc computers, Fortran.

The subroutine HDES5 contains a numerical method for solving a system of first-order differential equations. Some features of the HDES5 subroutine are as follows: a fifth order predictor--corrector method is used; it performs very well in comparison with other differential equation system solver subroutines; it is easy to incorporate into large-scale computer programs; it has relatively low core storage requirements; the execution times are low for relatively smooth problems.

HMI-B-219 MF **A01**
Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (West Germany). Bereich Datenverarbeitung und Elektronik.
LINFIT - an Interactive Program for Linear Least Squares Fit
R. Schmidt, D. Stein, and C. Vidic. Dec 76, 79p
Available in microfiche only. U.S. Sales Only.

Descriptors: *Computer codes, *Least square fit, Computer calculations, L codes, Matrices, Recursion relations.
Identifiers: ERDA/990200, West Germany, Curve fitting, LINFIT computer program.

LINFIT is an interactive program for fitting experimental data by linear models in the least squares sense by means of recursive matrix methods. The fitting functions can be chosen by the user from an internal as well as from an user-generated set of functions. Since these functions may depend on two parameters, a nonlinear fit is possible via man-machine interaction. For input and output a graphical display is needed. There are the following dialog-components: Select model functions, linear fit, correction of the model by adding, deleting or changing one of the functions, optical and statistical tests, comparing the results of different fits. One special model involves cubic spline functions, whose knots may be chosen in different ways. (Atomindex citation 08:333204)

IFVE-PPK-76-8 MF **A01**
Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergii.
KIOWA-Simple Program for Data Statistical Analysis on the ICL-1900 Computer
A. S. Karpenko, and Yu. L. Petrovykh. 1976, 20p
In Russian.
Available in microfiche only. U.S. Sales Only.

Descriptors: *Data processing, Fortran, Gaussian processes, ICL computers, K codes, Monte Carlo method, Statistics.
Identifiers: ERDA/990200, USSR, *KIOWA computer program, ICL-1900 computers, *Statistical analysis, Computer codes.

KIOWA is a simple program for statistical analysis of the data. The data can be read from DST (Data Summary Tape), obtained in the on-line experiments, from some program through interprogram channel and other sources. The program KIOWA produces one and two dimensional histograms and Gaussian ideograms. The standard computer line printer is used for the output. The user controls the program by means of the user coded FORTRAN routines (some other fortran compatible languages are can be also used) and also by means of the key-words. The main ideas and part of the coding are taken from KIOWA program coded in Berkeley. (Atomindex citation 08:335569)

IS-T-675 PC **A06**/MF **A01**
Ames Lab., Iowa.
Iterative Method for Fredholm Equations of the First Kind.
W. C. Peterson. May 75, 115p
Contract W-7405-eng-82

Descriptors: *Fredholm equation, *Iterative methods, Algorithms, Computer codes, Errors, Integral equations, Least square fit, Series expansion.

An iterative method is developed to find an approximation to the least squares solution of minimum norm, f sub 0 , of an operator equation, Kf = g, of the first kind. In applications to integral equations, the superfluous oscillations in the final solution of methods in the literature are not an apparent problem. Letting K: H sub 1 implies H sub 2 be a completely continuous operator from a real separable Hilbert space H sub 1 to a real Hilbert space H sub 2 , a sequence converging to f sub 0 is constructed, and stability and error bounds are obtained. (1 figure, 2 tables, 25 references).

IS-3174 PC **A02**/MF **A01**
Ames Lab., Iowa.
Computer Program for Solving Non-Linear Systems of Equations
D. D. Georg, and R. F. Keller. Jul 73, 22p
Contract W-7405-eng-82

Descriptors: *Equations, *Numerical solution, Algorithms, Computer codes, Fortran, Iterative methods, Nonlinear problems.
Identifiers: AEC.

For abstract, see NSA 28 10, number 26831.

IS-3179 PC **A03**/MF **A01**
Ames Lab., Iowa.
Interactive Computer Programs for Linear and Non Linear Projection Methods
J. A. Schmitz, D. D. Georg, and R. F. Keller. Jul 73, 46p
Contract W-7405-eng-82

Descriptors: *Equations, *Iterative methods, Computer codes, Jacobian function, Matrices, Nonlinear problems, Numerical solution.
Identifiers: AEC.

For abstract, see NSA 28 10, number 26832.

Juel-1377 MF **A01**
Kernforschungsanlage Juelich G.m.b.H. (West Germany). Inst. fuer Nukleare Sicherheitsforschung.

LUSHPLOT - a Fortran Program for Test and for Interpretation of the Results of Finite-Element-Calculations
D. Koschmieder, and J. Altes. Dec 76, 26p
In German.
Available in microfiche only. U.S. Sales Only.

Descriptors: *Finite element method, Computer calculations, Computer codes, Diagrams, Earthquakes, Fortran, L codes, Plotters.
Identifiers: ERDA/990200, West Germany, LUSHPLOT computer program.

When using finite-element-methods, it is of great improtance to be able to test the continuity of data, the correctness of co-ordinates and of elements prior to a computation and to be able to interpret the extensive results which arise from the calculation itself. It is desirable, therefore, to develop test procedures which allow a rapid, visual search for mistakes in data and a portrayal of the results. A finite-element-program system called LUSH, developed at Berkeley University, California, for earthquake calculations was supplemented by a plotting program called LUSHPLOT. With this routine geometrical data can be tested before the calculation runs and the results of the runs can be interpreted. (Atomindex citation 08:335570)

JAERI-M-7229 PC **A03**/MF **A01**
Japan Atomic Energy Research Inst., Tokyo.
New Method for Nonlinear Optimization Problems with a Few Variables
T. Suzuki. Aug 77, 26p
U.S. Sales Only.

Descriptors: *Computer codes, *Optimization, Algorithms, Errors, Functions, Iterative methods, Mathematical models, Nonlinear problems, Numerical solution, S codes, Spheres.
Identifiers: ERDA/990200, Japan, Nonlinear optimization, SCOOP system.

A new method has been developed for solving nonlinear optimization problems with a few variables. It is an iterative method of searching the optimum point on a spherical surface in each iteration process by evaluating values of the objective function at several given points on the sphere and then moving the searching sphere in a direction giving the minimum objective. The method is useful for the problems represented with the contours having narrow curves or deep valleys, such as the Rosenbrock's function and Beale's function, which are test functions in the present report. The new approach has been introduced in optimization code system SCOOP. (Atomindex citation 09:380156)

JINR-P5-7259 PC **E03**/MF **A01**
Joint Inst. For Nuclear Research, Dubna (Ussr). Lab. Of Computing Techniques and Automation.
Program for Solving Non-Linear Systems of Equations on the Basis of Regularization Iteration Processes by Gauss--Newton
L. Aleksandrov. 1973, 72p
In Russian. U.S. Sales Only.

Descriptors: *Computer codes, *R codes, Equations, Fortran, Mathematical operators, Nonlinear problems.
Identifiers: AEC.

For abstract, see NSA 28 10, number 26889.

JPRS-54168 PC **A03** MF **A01**
Joint Publications Research Service, Washington, D.C.
Computer Analysis and Mathematical Modeling
V. V. Kolbin, I. M. Syroezhin, and F. G. Gurvich. 1 Oct 71, 26p
Trans. of Ekonomika i Matematicheskie Metody (USSR) v5 n1 p63-72, 153-157 1969.

Descriptors: *Game theory, Computer programming, *Management planning, Mathematical models, Decision theory, Production control, Stochastic processes, Linear programming, Optimization, Translations, USSR.
Identifiers: Computer aided analysis.

Contents:
Computer Analysis of Business Games;
Mathematical Models of Planning and Control of Scientific Research.

K/CSD/INF-76/3 PC **A02**/MF **A01**
Union Carbide Corp., Oak Ridge, Tenn. Computer Sciences Div.
Petri Net as a Modeling Tool
P. B. Thomas. 1976, 10p Rept no. CONF-760430-1
14. annual conference of southeast regional association for computing machinery, Birmingham, Alabama, United States of America (USA), 22 Apr 1976.

Descriptors: *Computer codes, Programming languages.
Identifiers: ERDA/990200, *Petri nets, Mathematical models, Computerized simulation.

The Petri net model is presented as a modeling tool for coordination of asynchronous processes. The Petri net is defined and shown to be both flexible in representing concurrency and easy to comprehend. An extended Petri net model is introduced, and its greater flexibility for coordination modeling is demonstrated. The Cigarette Smokers' Problem is modeled with a Petri net, and a Producer--Consumer Problem is solved with the extended Petri net. The net is briefly evaluated with mention of results of an experimental high-level language simulation of the extended Petri net. (ERA citation 01:022347)

K/CSD/TM-14 PC **A03**/MF **A01**
Oak Ridge Gaseous Diffusion Plant, Tenn.
Installation of DSS/2 on the IBM 360/195 Computer at K-25
D. M. Lister. Jun 77, 35
Contract W-7405-ENG-26

Descriptors: *Computer codes, *Differential equations, Accuracy, D codes, Fortran, Ibm computers, Numerical solution, Programming.
Identifiers: ERDA/990200, *DSS/2 computer program, IBM-360/195 computers.

The Differential Systems Simulator, Version 2(DSS/2), is a software package that can be used to solve sets of differential equations. This report discusses the work performed in implementing the package on the IBM 360/195 at K-25. It records the names of the data sets produced and the JCL procedures used. It is not intended as a detailed programer's guide for the installation of a system such as DSS/2. 7 figures, 2 tables. (ERA citation 02:057810)

K/CSD/TM-6 PC **A04**/MF **A01**
Oak Ridge Gaseous Diffusion Plant, Tenn.
Routines for Interpolation Using Cubic Splines and Pseudosplines
J. E. Park. Oct 77, 54p

Descriptors: *Interpolation, Computer codes, E codes, Fortran, IBM computers, Matrices, P codes, S codes.
Identifiers: ERDA/990200, Spline interpolation.

With the continuity of the first derivative at the knots as a unifying concept, the equation sets describing two cubic splines are developed. The resulting systems of linear equations have tridiagonal coefficient matrices; FORTRAN routines to generate these matrices are presented. Several interpolation problems are solved; the solutions are discussed. 13 figures, 2 tables. (ERA citation 03:032501)

K/UR-8 PC **A04**/MF **A01**
Oak Ridge Gaseous Diffusion Plant, Tenn.
Computer Program to Generate Pearson, Spearman, and Kendall Correlations
V. E. Kane, N. M. Larson, and V. C. Nall. Nov 77, 60p
Contract W-7405-ENG-26

Descriptors: *Computer codes, *Statistics, Correlation functions, Fortran, IBM computers, S codes.
Identifiers: ERDA/990200, SPEKEN computer program.

The computer program SPEKEN computes Pearson, Spearman, and Kendall correlation coefficients for multivariate data. Special features of the program include exclusion of pairs of data values where at least one value is missing. Additionally, the Spearman and Kendall nonparametric measures of correlation have adjustments for tied rankings. The hypothesis of independence between each pair of variables can be tested by use of the obtained significance level for each correlation. A large-sample approximation is used for the nonparametric correlations, and the program forces use of tables for fewer than fifteen pairs of samples. 1 figure, 9 tables. (ERA citation 03:020799)

KAPL-M-7339 PC **A06**/MF **A01**
Knolls Atomic Power Lab., Schenectady, N.Y.
Radl Geometry Modules.
R. H. Jr. Beam, and H. J. Kopp. Jun 74, 111p
Contract W-31-109-eng-52

Descriptors: *Geometry, *Two-dimensional calculations, Comparative evaluations, Computer calculations, Computer codes, Interfaces, Manuals, Operation, Programming, Standards.

For abstract, see NSA 30 08, number 23307.

KFK-PDV-31 PC **A04**/MF **A01**
Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F.R. Germany).
Linear Cost Minimization with Process Computer.
F. Hock, and G. Schaffrath. Jan 75, 62p
In German. U.S. Sales Only.

Descriptors: *On-line control systems, *Optimization, *Linear programming, *Computer codes, Computers, Cost, Performance, Reviews, Uses.
Identifiers: ERDA/990200.

The objective of the project was the cost minimization of processes. By means of this system the plant engineer has the possibility of steering the processing parameters to optimize the costs during course of operation. Methods of linear programing were adapted to the requirements of process computers and process control. This report gives a review of applications of and experiences with a software package for linear programing.

KFK-2175 PC **A03**/MF **A01**
Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Neutronenphysik und Reaktortechnik.
Ipol: A Fortran Routine for Two Dimensional Interpolation.
C. Guenther. Nov 75, 32p
U.S. Sales Only.

Descriptors: *Computer codes, *Interpolation, Polynomials, Fortran, I codes, Two-dimensional calculations.
Identifiers: ERDA/990200, West Germany, *IPOL computer program.

Let a set of N real points, (x/sub i/, y/sub i/), i = 1, 2, .., N, be given. The FORTRAN subroutine IPOL calculates a maximum number v greater than or equal to 1 of linearly independent polynominals, P sub 1 (x,y), ..., P/sub v/(x,y), which are of least possible degree g and which have the (x/sub i/, y/sub i/) as zeros, P/sub K/(x/sub i/, y/sub i/) = O for i = 1, 2, ..., N and K = 1, ..., v. IPOL is used to find polynominals P(x,y) vanishing in a given point set. This is done by setting P(x,y): = P sub 1 (x,y) if v = 1, and if v > 1 by taking a suitable linear combination of P sub 1 (x,y), ..., P/sub v/(x,y). An example is given for a multivariate interpolation problem. In addition, an aspect of numerical integration can be clarified by the use of IPOL. For some quadrature formulas of polynominal degree 2l-1 in two dimensions, the number of linearly independent polynominals of degree l which have the points of these formulas as zeros is given. 2 figures, 1 table. (ERA citation 01:012305)

KFK-2303 MF **A01**
Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik.

Modint - a Fortran-IV Code for Interpolation Grid-Functions of Two and Three Variables
K. Kuefner. Jul 76, 35p
Available in microfiche only. In German, 4 figs.; 6 tabs.; 24 refs. With apps.
U.S. Sales Only.

Descriptors: *Computer codes, *Interpolation, Mathematics, Algorithms, Coordinates, M codes, Programming, Three-dimensional calculations, Two-dimensional calculations.
Identifiers: ERDA/990200, West Germany, *Modint computer program.

MODINT interpolates functions of two and three independent variables by using a generalized Newton-scheme (divided differences). Theory and application are restricted to cartesian grid-functions (in particular the general problem of multidimensional fitting is not solved). Literature given as well as the modular design of the programme should enable a user to move to another interpolation algorithm if necessary. (Atomindex citation 07:279517)

LA-NUREG-6526-MS PC **A02**/MF **A01**
Los Alamos Scientific Lab., N.Mex.
Report on the Application of Statistical Techniques to the Analysis of Computer Codes
M. D. McKay, W. J. Conover, and D. E. Whiteman. Aug 76, 15p
Contract W-7405-ENG-36

Descriptors: *Computer codes, *Sampling, Correlation functions, Distribution functions, Monte carlo method, Statistics.
Identifiers: ERDA/990200.

Two types of sampling plans are presented as alternatives to simple random sampling in Monte Carlo studies. These plans are shown to be improvements over simple random sampling with respect to the variance of a class of estimators which includes the sample mean and the sample cumulative distribution function. The partial rank correlation coefficient is presented as a measure of sensitivity. Examples and test cases are included. 14 figures, 5 tables. (ERA citation 02:015630)

LA-UR-74-1262 PC **A02**/MF **A01**
Los Alamos Scientific Lab., N.Mex.
New Transport Methods and Codes.
K. D. Lathrop. 1974, 9p Rept no. CONF-740903-5
Contract W-7405-eng-36

Descriptors: *Boltzmann equation, *Numerical solution, *Computer codes, *F codes, Finite element method, Iterative methods, T codes, Transport theory.

For abstract, see NSA 30 12, number 34032.

LA-UR-75-2013 PC **A02**/MF **A01**
Los Alamos Scientific Lab., N.Mex.
Capacitance Matrix Technique.
B. L. Buzbee. 1975, 10p Rept no. CONF-750987-1
Contract W-7405-ENG-36

Descriptors: *Matrices, *Poisson equation, Computer codes, Equations, Mathematical models, Mathematics.
Identifiers: ERDA/990200.

The capacitance matrix technique is a modification method that is associated with elliptic difference systems and is characterized by a modification of rows. A unified development of this technique where the preprocessing phase on an n by n mesh requires O(pn exp 2 + p exp 3) operations is presented. The capacitance method and the matrix decomposition Poisson solver are developed.

LA-UR-76-2298 PC **A02**/MF **A01**
Los Alamos Scientific Lab., N.Mex.
Certification of the Swarztrauber--Sweet Elliptic PDE Software Package
B. L. Buzbee. 1976, 6p Rept no. CONF-760740-1
Contract W-7405-ENG-36
Springer lecture series numerical treatment of differential equations meeting, Freiburg, German, Federal Republic of (F.R. Germany), 6 Jul 1976.

Descriptors: *Computer codes, *Differential equations, *Finite difference method, Fortran, Numerical solution, Testing, Two-dimensional calculations.
Identifiers: ERDA/990200, West Germany, *Elliptic differential equations, *Partial differential equations.

Recent years have seen the development of efficient direct methods for solving finite difference approximations to the Helmholtz equation on a rectangle with simple boundary conditions. Swarztrauber and Sweet have incorporated these techniques into an "on-the-shelf" software package written in ANSI FORTRAN (Efficient FORTRAN subprograms for the solution of elliptic partial differential equations, NCAR-TN/IA-109). The present report describes the use and testing of this package in general terms. (ERA citation 02:021478)

LA-UR-77-1345 PC **A02**/MF **A01**
Los Alamos Scientific Lab., N.Mex.
INGEN: A General Purpose Mesh Generator for Finite Element Codes
W. A. Cook. 1977, 23p Rept no. CONF-770813-3
Contract W-7405-ENG-36
ADINA conference, Cambridge, Massachusetts, United States of America (USA), 4 Aug 1977.

Descriptors: *Boundary value problems, *Computer codes, *Finite element method, Coordinates, I codes, Interpolation, Numerical solution, Pinch devices, Pressure vessels, Reactor components, Three-dimensional calculations, Two-dimensional calculations.
Identifiers: ERDA/990200, ERDA/700201, ERDA/220200, INGEN computer program.

INGEN is a general purpose mesh generator for two- and three-dimensional finite-element codes. The basic parts of the code are surface and three-dimensional region generators that are linear-blending interpolation formulas. These generators are based on an i, j, k index scheme which is used to number nodal points, construct elements, and develop displacement and traction boundary conditions. 12 figures, 2 tables. (ERA citation 02:057812)

LA-4423 HC A03 MF **A01**
Los Alamos Scientific Lab., N. Mex.
Four Computer Programs Using Green'S Third Formula to Numerically Solve Laplace'S Equation In Inhomogeneous Media.
John K. Hayes. Apr 70, 41p
Contract W-7405-eng-36

Descriptors: *Harmonic functions, Boundary value problems, *Numerical integration, *Computer programming, Approximation.
Identifiers: *Laplace equation, Poisson equation, LAPLACE computer program, LAPLARS computer program, LAPLDDC computer program, LAPLDRS computer program.

For abstract, see NSA 2418

LA-4796 PC **A04**/MF **A01**
Los Alamos Scientific Lab., N. Mex.
Graphical Representation of Two-Variable Data
Nicholas J. Nagy Iii. Nov 71, 71p
Contract W-7405-ENG-36

Descriptors: *Computer programs.

For abstract, see NSA 26 05, number 11451.

LA-5803 PC **A02**/MF **A01**
Los Alamos Scientific Lab., N.Mex.
Gaussian Elimination for Dense Systems on Star and a New Parallel Algorithm for Diagonally Dominant Tridiagonal Systems.
T. L. Jordan. Jun 75, 13p
Contract W-7405-eng-36

Descriptors: *Computer codes, *D codes, *Equations, *Numerical solution, Algorithms, Cdc computers, Fortran, L codes, Matrices, Performance, T codes, Vectors.
Identifiers: ERDA/990200.

STAR-100 properties that influence algorithm performance are discussed. Three methods for implementing Gaussian elimination for dense linear systems are also discussed. They differ in storage assignment, indexing techniques, etc. Arithmetic cancellation can be monitored dynamically within the selected method. A new parallel algorithm is given for solving diagonally dominant tridiagonal systems. The algorithm requires ln sub 2 n parallel steps, where each parallel step consists of 8 multiplies, 4 adds, and 1 divide of vectors of average length almost n. However, in the case of strict diagonal dominance, the algorithm may converge in fewer than ln sub 2 n steps, and thereby truncate the process. Comparisons of time required for systems of various orders are Standard FORTRAN codes, tested on the CDC 7600, are available for the general linear system; the dense, symmetric, positive definite case; and the diagonally dominant tridiagonal system. The vectorizable portions of the codes are identified and written so that they can be easily translated to the vector syntax of the STAR CDD-FORTRAN. In each code, all floating point arithmetic can be implemented with STAR-100 vector instructions.

LA-6187-MS PC **A02**/MF **A01**
Los Alamos Scientific Lab., N.Mex.
Jacobi Algorithms for Integers.
R. W. Johnson, and M. S. Waterman. Dec 75, 15p
Contract W-7405-ENG-26

Descriptors: *Computer codes, *J codes, Algorithms, FORTRAN.
Identifiers: ERDA/990200, *Jacobi method, Greatest common divisors, Computations.

Jacobi's algorithm, usually given for pairs of reals, has an integer analog for triples of integers. This algorithm and an alternative algorithm are presented along with the connection with computing greatest common divisors. A technique of D. H. Lehmer's is generalized for efficient computation of Jacobi algorithms. Listings of FORTRAN programs for these procedures are given.

LA-6479-MS PC **A02**/MF **A01**
Los Alamos Scientific Lab., N.Mex.
Report on the Application of Statistical Techniques to the Analysis of Computer Codes
M. D. McKay, W. J. Conover, and D. E. Whiteman. Aug 76, 15p
Contract W-7405-Eng-36

Descriptors: *Computer calculations, *Sampling, Computer codes.
Identifiers: ERDA/990200.

Two types of sampling plans are presented as alternatives to simple random sampling in Monte Carlo studies. These plans are shown to be improvements over simple random sampling with respect to the variance of a class of estimators which includes the sample mean and the sample cumulative distribution function. The partial rank correlation coefficient is presented as a measure of sensitivity. Examples and test cases are included. 14 figures, 5 tables. (ERA citation 02:012130)

LA-6668-T PC **A04**/MF **A01**
Los Alamos Scientific Lab., N.Mex.
Proof of Convergence for the Tridiagonal Ql Algorithm In Floating-Point Arithmetic
J. G. Sanderson. Jan 77, 71p
Contract W-7405-ENG-36
Thesis.

Descriptors: *Computer codes, *Matrices, Algorithms, Algol, E codes, Eigenvalues, Ibm computers, Mathematics, Numerical solution, T codes.
Identifiers: ERDA/990200, Floating point operation, Computation.

Numerous routines are available to find the eigenvalues of a real symmetric tridiagonal matrix. Since

it is known to converge in exact arithmetic, the tridiagonal QL algorithm with origin shift is widely used. This algorithm is analyzed here in floating-point arithmetic. This analysis suggests two modifications to the EISPACK implementation TQL1 that enable one to prove correctness and, hence, convergence of the routine. Also, it is known that the implicit and explicit versions of the QL algorithm produce the same results in exact arithmetic. A counter-example to the floating-point analog of this theorem is presented. (ERA citation 02:033565)

LA-6833-MS PC **A02**/MF **A01**
Los Alamos Scientific Lab., N.Mex.
Numerical Code for the Three-Dimensional Parabolic Wave Equation
J. C. Goldstein. Jun 77, 19p
Contract W-7405-ENG-36

Descriptors: *Computer codes, *Wave equations, Visible radiation, Diffraction, Fortran, Nonlinear problems, Numerical solution, T codes, Three-dimensional calculations, Wave propagation.
Identifiers: ERDA/990200, ERDA/657005.

Various features of a code designed to solve the three-dimensional parabolic wave equation with an added nonlinear (self-focusing) term are summarized. Some exact conservation laws of the full nonlinear equation are considered. The precise numerical method used to solve the equation is explicitly displayed. Comparisons of numerically computed results with exact results for a sample pure diffraction problem are made. A discussion of various input data for the code, which now exists in two different versions, is given. 12 figs., 2 tables. (ERA citation 02:053577)

LA-6903-MS PC **A02**/MF **A01**
Los Alamos Scientific Lab., N.Mex.
Rational Function Method of Interpolation
G. I. Kerley. Aug 77, 20p
Contract W-7405-ENG-36

Descriptors: *Computer codes, *Interpolation, Functions, Algorithms, Calculation methods, F codes, Fortran, Polynomials, Tables.
Identifiers: ERDA/990200, Rational functions.

A new method for interpolating functions of one and two variables from tables is presented. The technique uses a ratio of polynomials to represent the function on an interpolation interval. A quadratic formula is used to estimate derivatives at the tabular points. The method is particularly useful for functions which have rapid or even discontinuous changes in the first derivative at certain points. 6 figures, 2 tables. (ERA citation 02:061835)

LBL-4648 PC **A02**/MF **A01**
California Univ., Berkeley Lawrence Berkeley Lab.
Improved Shift Strategy for the Qr-Algorithm for Real Hessenberg Matrices.
I. Karasalo. Jan 76, 19p
Contract W-7405-Eng-48

Descriptors: *Computer codes, *Q codes, *Matrices, Computer codes, Algol, Algorithms, Eigenvalues, Numerical solution, Performance.
Identifiers: ERDA/990200, *Hessenberg matrices.

Some experimental results on the behavior of the QR algorithm for real Hessenberg matrices are presented, with shifts calculated from a p x p lower right-hand submatrix where p may be >2. Convenient implementation of one such shifting strategy in a programing language is discussed; recursive procedure calls are permitted by modifying slightly the ALGOL procedure HQR (Martin, Peters, and Wilkinson, Numer. Math. 14, 219-31 (1970)). In the comparison the modified procedure gives in general a 15 to 20% reduction of the total operations count for transforming the Hessenberg matrix to block triangular form (with diagonal blocks of order less than or equal to2) and updating the product of the orthogonal transformation matrices. 7 tables.

LBL-7516 MF **A01**
California Univ., Berkeley. Inst. of Marine Resources.
Four FORTRAN Programs for Numerically Solving Helholtz's Equation in an Arbitrary Bounded Planar Region
W. Proskurowski. Feb 78, 112p Rept no. CONF-780331-2
Contract W-7405-ENG-48
Conference of mathematical software, Austin, TX, USA, 29 Mar 1978,

Descriptors: *Computer codes, *Differential equations, CDC computers, Dirichlet problem, Fortran, H codes, Matrices, Numerical solution, Two-dimensional calculations.
Identifiers: ERDA/990200, *Helmhotz equation, HLMHLZ computer program, HELMIT computer program, HELSIX computer program, HELSYM computer.

In recent years special techniques known as the capacitance matrix methods (CMM) have been developed for the numerical solution of Helmholtz's equation in a general bounded planar region - delta u + cu = f in omega , where c is a real constant, with either Dirichlet or Neumann conditions on the boundary. These methods make use of fast solvers in regions that allow for the separation of variables. There are two major variants of such methods: one in which the capacitance matrix is actually generated and LU-factored, and the other in which the capacitance matrix is used implicitly to compute a matrix-vector product in an iterative process. Explicit CMM are designed for repetitive use, i.e., with different functions f (while the constant c, the geometry of the problem and the mesh are unchanged). An important advantage of a CMM program is that it can be speeded up whenever a new and faster separable solver is available, by replacing a proper subroutine. A collection of four FORTRAN programs is presented: HLMHLZ is an implicit solver, recommemded for use when only one problem is to be solved or the amount of available core storage is limited; HELMIT is an explicit solver for general use when the same problem is to be solved with different functions f; HELSIX is a high-order explicit Poisson solver (with Dirichlet conditions only); HELSYM is an explicit solver for use in solving eigenvalue problems (with zero Dirichlet conditions only. These programs are limited to two-dimensional regions. 1 figure, 5 tables. (ERA citation 03:042089)

LRP-90/75 PC **A03**/MF **A01**
Ecole Polytechnique Federale, Lausanne (Switzerland).
Hymnia: Band Matrix Package for Solving Eigenvalue Problems.
R. Gruber. Feb 75, 29p
U.S. Sales Only.

Descriptors: *Computer codes, *H codes, *Eigenvalues, *Computer calculations, Fortran, Hermitian matrix, Mathematics, Matrices, Programming languages, Vectors.
Identifiers: ERDA/990200.

For abstract, see NSA 7504

NUREG/CR-0293 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, NM.
Comparison of Shortest Path Algorithms Applied to Sparse Graphs
B. L. Hulme, and J. A. Wisniewski. Aug 78, 48p
Rept no. SAND-78-1411
Contract EY-76-C-04-0789

Descriptors: Adversaries, Algorithms, Computer codes, Distance, CDC computers, Comparative evaluations, Computer calculations, Fortran, Fuel cycle, Optimization, S codes, Safeguards, U codes, Vulnerability.
Identifiers: ERDA/990200, ERDA/055001, *Graph theory, Shortest path method.

Three methods are compared for finding shortest paths from one node to all other nodes in sparse, nonnegatively weighted, directed graphs. Dijkstra's method with a heap sort, Ford's method with a sequence list, and Yen's method are considered the best representatives of certain classes of methods for this problem. They have essentially the same storage requirements and are compared on the basis of algorithm execution time for a test set of randomly generated problems. For directed graphs that are sufficiently sparse, Ford's method with a sequence list is the fastest of the three methods. A different version of Ford's algorithm is proposed for use in the special case of undirected sparse graphs in order to make efficient use of the symmetry of the distance matrix. (ERA citation 04:002127)

N70-23320/CP HC A05 MF **A01**
Texas Univ., Austin.
Two Square Root Algorithms Utilizing Multiplication as the Iterative Operator.
J. R. Goodman. Aug 69, 86p Rept no. NASA-CR-109329
Contract NGR-44-012-144

Descriptors: *Algorithms, *Computer programming, *Hardware, *Multipliers, Computerized simulation, Iterative solution, Root-mean-square errors.

For abstract, see STAR 0810

N70-23435/CP HC A04 MF **A01**
International Business Machines Corp., Cambridge, Mass. Federal Systems Div.
Independent Research and Development Program, Task No. 0216 - Lame Functions of the First Kind Generated by Computer Final Report.
H. G. Walter. Nov 69, 62p
Spon- Sponsored Partly By Esro

Descriptors: *Computer programs, *Fortran, *Lame functions, Algebra, Boundary value problems, Differential equations, Eigenvalues, Polynomials.

For abstract, see STAR 0810

N70-25372/CP HC A04 MF **A01**
Smithsonian Astrophysical Observatory, Cambridge, Mass.
Smithsonian Package for Algebra and Symbolic Mathematics.
J. R. Cherniack, and N. M. Hall. 29 Jan 69, 55p
Rept nos. NASA-CR-109529, SAO-SPECIAL-REPT-291
Contract NGR-09-015-002

Descriptors: *Algebra, *Computer systems programs, *Machine oriented languages, *Symbolic programming, Computer programs, Data processing.

For abstract, see STAR 0812

N70-26305/CP HC A02 MF **A01**
Laboratoire de Recherches Balistiques Et Aerodynamiques, Vernon (France).
Fast Fourier Transformations.
Transformation de Fourier Rapide
5 Nov 69, 22p Rept no. LRBA-NT-46-69-BT-SAT
Lang- in French

Descriptors: *Algorithms, *Binomial coefficients, *Fourier transformation, Binary data, Computer programs, Discrete functions, Fortran, Periodic functions, Subroutines, Time lag.

For abstract, see STAR 0812

N70-27160/CP HC A05 MF **A01**
Bellcomm, Inc., Washington, D. C.
Pap - Parametric Analysis Program.
P. F. Long. 21 Jan 70, 93p Rept nos. NASA-CR-109832, TM-70-1032-1
Contract NASW-417

Descriptors: *Computer programs, *Nonlinearity, *Parameterization, Conformal mapping, Flow charts, Independent variables, Interpolation, Plotting.

For abstract, see STAR 0813

N70-28860/CP HC A04 MF **A01**
Nationaal Lucht-en Ruimtevaartlaboratorium, Amsterdam (Netherlands).

An Application of the n-Strip Method of Integral Relations for Analyzing the Flow around a Circular Cone.
H. I. Baurdoux, and P. J. Zandbergen. 1969, 52p
Rept no. NLR-TR-69020-U

Descriptors: *Algorithms, *Circular cones, *Conical flow, *Problem solving, *Supersonic flow, Asymptotic series, Boundary value problems, Computer programs, Matrices (mathematics), Partial differential equations, Pressure distribution.

For abstract, see STAR 0814

N70-29003/CP HC A04 MF **A01**
Nationaal Lucht-en Ruimtevaartlaboratorium, Amsterdam (Netherlands).
High-Order Accuracy Numerical Integration of Second-Order Ordinary Differential Equations by Means of Nordsieck'S Method.
C. R. Traas. 1969, 53p Rept no. NCR-TR-69040-U

Descriptors: *Differential equations, *Runge-kutta method, *Satellite orbits, Artificial satellites, Computation, Computer programs, Eigenvalues, Integral calculus, Mathematical models, Orbital mechanics, Predictions, Taylor series.

For abstract, see STAR 0814

N70-29868/CP HC A02 MF **A01**
Aeronautical Research Labs., Melbourne (Australia).
A Curve Fitting Technique Using Orthogonal Polynomials.
M. G. Higgs. Jun 69, 17p Rept no. ARL/SM-338

Descriptors: *Curve fitting, *Legendre functions, *Polynomials, Computer programs, Orthogonal functions, Set theory.

For abstract, see STAR 0815

N70-31927/CP HC A10 MF **A01**
National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
Smooth Empirical Bayes Estimation with Application to the Weibull Distribution.
G. K. Bennett. Jun 70, 222p Rept no. NASA-TM-X-58048
Contract NGR-44-011-029

Descriptors: *Bayes theorem, *Weibull density functions, Computer programs, Estimates, Monte carlo method, Random variables.

For abstract, see STAR 0816

N70-33412/CP HC A06 MF **A01**
Technische Hogeschool, Eindhoven (Netherlands).
Boundary Properties of Penalty Functions for Constrained Minimization.
F. A. Lootsma. 15 May 70, 111p

Descriptors: *Constraints, *Jacobi matrix method, *Nonlinear programming, Computer programs, Matrices (mathematics).

For abstract, see STAR 0818

N70-33792/CP HC A04 MF **A01**
Lockheed Electronics Co., Houston, Tex. Aerospace Systems Div.
Genhyp - a Fortran 5 Program for General Linear Hypothesis Testing.
F. C. Delaney, and F. N. Speed. May 70, 55p
Rept no. NASA-CR-108499
Contract NAS9-5384

Descriptors: *Computer programs, *Linear systems, *Squares (mathematics), *Statistical analysis, Data processing, Fortran, Hypotheses, Mathematical models, Sum rules, Tables (data).

For abstract, see STAR 0818

N70-34233/CP HC A05 MF **A01**
Georgia Univ., Athens. Dept. of Statistics.
Tables of Maximum Likelihood Estimating Functions for Singly Truncated and Singly Censored Samples from the Normal Distribution.
A. C. Cohen, and C. G. Cooley. Apr 70, 100p
Rept nos. NASA-CR-61330, TR-54
Contract NAS8-11175

Descriptors: *Computer programs, *Normal density functions, *Random sampling, *Statistical analysis, Approximation, Maximum principle, Random variables.

For abstract, see STAR 0818

N70-35525/CP HC A02 MF **A01**
Bellcomm, Inc., Washington, D. C.
Evaluation of Routines for Numerical Solution of the Matrix Equation AX < Xa Sup T < B > 0.
P. R. Dowling, and P. G. Smith. 25 Jun 70, 21p
Rept nos. NASA-CR-110026, B70-06073
Contract NASW-417

Descriptors: *Computer programs, *Covariance, *Liapunov functions, *Matrices (mathematics), Differential equations, Linear systems, Problem solving, Time dependence.

For abstract, see STAR 0819

N70-35673/CP HC A02 MF **A01**
National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
Pseudoinversion for Operator'S Defined on Finite Dimensional Hilbert Spaces.
J. L. Engvall. Sep 67, 19p Rept nos. NASA-TM-X-64456, MSC-67-ED-R-59

Descriptors: *Algorithms, *Hilbert space, *Linear transformations, *Operators (mathematics), Computer programs, Error functions.

For abstract, see STAR 0819

N70-35743/CP HC A03 MF **A01**
National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
Efficiency of Generalized Matrix Inversion Methods.
F. C. Delaney, G. G. Gaffney, and F. M. Speed. 1 Sep 66, 38p Rept nos. NASA-TM-X-64453, MSC-66-ED-41

Descriptors: *Computer programs, *Matrices (mathematics), *Matrix theory, Algorithms, Least squares method, Tables (data).

For abstract, see STAR 0819

N70-36072/CP HC A04 MF **A01**
European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center.
Spectral Parameter Estimation for Linear System Identification.
A. C. Lucia. May 70, 59p Rept no. EUR-4479-E

Descriptors: *Ergodic process, *Error analysis, *Estimating, *Linear systems, *Power spectra, Computer programs, Determinants, Fourier transformation.

For abstract, see STAR 0819

N70-36789/CP HC A04 MF **A01**
State Inst. for Technical Research, Helsinki (Finland). Lab. of Concrete Technology.
An Approximate Solution of a Quasi-Linear Diffusion Problem - Tables and Nomograms for Concentration in Slabs in a Special Case.
S. S. Kasi, and S. E. Pihlajavaara. 1969, 74p
Spon- Sponsored By State Commission for Technology

Descriptors: *Concretes, *Diffusion, *Nomographs, *Nonlinearity, *Problem solving, *Tables (data), Computer programs, Finite difference theory, Numerical analysis, Parabolic differential equations, Partial differential equations.

For abstract, see STAR 0820

N70-36918/CP HC A03 MF **A01**
Imperial Coll. of Science and Technology, London (England). Thermofluids Section.
Heat and Mass Transfer in Recirculating Flows. Lecture 2 - Finite-Difference Equations.
D. B. Spalding. Dec 68, 29p Rept no. EF/TN/A/6
Conf- Lecture Presented At Post-experience Course, London, 17-19 Dec. 1968

Descriptors: *Finite difference theory, *Numerical analysis, *Partial differential equations, Computer programs, Conductive heat transfer, Convergence, Steady state.

For abstract, see STAR 0820

N70-40813/CP PC **A04** MF **A01**
Texas Center for Research, Austin.
Computing Procedures in Statistical Discriminate Analysis Three Lectures.
P. L. Odell. Jul 69, 61p Rept no. NASA-CR-108650
Contract NAS9-9903
Conf- Presented At Nasa. Manned Spacecraft Center, Houston, Jul. 1969

Descriptors: *Applications of mathematics, *Computer programs, *Statistical analysis, Bayes theorem, Mathematical models, Numerical analysis, Theorem proving.

For abstract, see STAR 0823

N71-10834/CP PC **A03** MF **A01**
Texas A+m Univ., College Station. Inst. of Statistics.
A Computer Program for the Mixed Analysis of Variance Model Based on Maximum Likelihood.
H. O. Hartley, and W. K. Vaughn. Aug 70, 48p
Rept nos. NASA-CR-111145, TR-3
Contract NGR-44-001-095

Descriptors: *Computer programs, *Maximum likelihood estimates, *Variance (statistics), Differential equations, Independent variables, Mathematical models, Matrices (mathematics), Steepest descent method.

For abstract, see STAR 0901

N71-11609/CP PC **A07**
Laboratoire D Automatique Et de Ses Applications Spatiales, Toulouse (France).
Contribution to the Analysis of Sampled Data Systems Using Associated Recurrences.
Contribution A l'Analyse de Systemes A Donnees Echantillonnees A l'Aide des Recurrences Associees
J.-L. Abatut. 1970, 131p
Refs Lang- in French Spon- Sponsored By Direc. des Rech. Et Moyens D'essais

Descriptors: *Data sampling, *Data systems, *Nonlinear systems, *Recursive functions, Automatic control, Computer programs, Oscillations, Stability, Transfer functions.

For abstract, see STAR 0902

N71-11658/CP PC **A02**
Compagnie Francaise Thomson Houston-hotchkiss Brandt, Paris. Groupe Prospective.
Relevance Trees.
Arbres de Pertinence
L. Gerardin. 28 May 70, 25p Rept no. LG/PB-LCR/DR2-554/70
Lang- in French

Descriptors: *Decision theory, *Partitions (mathematics), *Trees (mathematics), Computer programs, Graphs (charts), Operations research.

For abstract, see STAR 0902

N71-12904/CP PC **A03**
Royal Aircraft Establishment, Farnborough (England).
A Method of Calculating Sampling Errors.
J. W. Lloyd, and T. D. Reed. Aug 69, 40p Rept no. RAE-TR-69170

Descriptors: *Computer programs, *Data sampling, *Random errors, Integral equations, Interpolation, Pulse amplitude modulation.

For abstract, see STAR 0903

N71-14036/CP PC **A04** MF **A01**
Aerojet-general Corp., Sacramento, Calif. Nuclear Rocket Operations.
Tree Analysis Code (Trace) Program E64106. Nerva Program
H. R. Tayama, and T. N. Throckmorton. Oct 69, 55p Rept nos. NASA-CR-111366, RN-DR-173
Contract SNP-1

Descriptors: *Computer programs, *Computerized simulation, *Monte carlo method, *Systems analysis, Maximum likelihood estimates, Trees (mathematics).

For abstract, see STAR 0904

N71-14076/CP PC **A03**
Electricity Council Research Center, Capenhurst (England).
Runge- Kutta Methods for the Integration of Systems of Ordinary Differential Equations
P. Basnett. Mar 70, 33p Rept no. ECRC/N261

Descriptors: *Computer programs, *Differential equations, *Numerical integration, *Runge-kutta method, Subroutines.

For abstract, see STAR 0904

N71-15833/CP PC **A03** MF **A01**
National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
Allmat - a TSS/360 Fortran 4 Subroutine for Eigenvalues and Eigenvectors of a General Complex Matrix
G. Fair. Jan 71, 29p Rept nos. NASA-TN-D-7032, E-5885
Contract 129-02

Descriptors: *Computer programs, *Eigenvalues, *Eigenvectors, Fortran, Matrices (mathematics), Numerical analysis, Subroutines.

For abstract, see STAR 0906

N71-17185/CP PC **A03**
European Space Research and Technology Center, Noordwijk (Netherlands).
AUTOMATIC DERIVATION OF THE RIEMANN TENSOR IN AN N-DIMENSIONAL SPACE USING FORMAC/PL1
Derivation Automatique Du Tenseur de Riemann Dans Un Espace A N Dimensions A l'Aide Du Formac Pl1
F. A. Brunacci. Jun 70, 40p Rept no. ESRO-TM-151-ESTEC
Coll- 40 P Refs Lang- in French, English Summary

Descriptors: *Coordinates, *Pl/1, *Riemann manifold, *Tensor analysis, Computer programs, Dimensional analysis.

For abstract, see STAR 0907

N71-17411/CP PC **A04** MF **A01**
National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DYNAMIC DATA ANALYSIS TECHNIQUES USED IN THE LANGLEY TIMES SERIES ANALYSIS COMPUTER PROGRAM
R. C. Ward. Feb 71, 75p Rept nos. NASA-TM-X-2160, L-7360
Contract 129-20-04-02

Descriptors: *Computer programs, *Data reduction, *Instruction sets (computers), *Time series analysis, Power spectra, Probability density functions, Recursive functions.

For abstract, see STAR 0907

N71-19185/CP PC **A14** MF **A01**
International Business Machines Corp., Cambridge, Mass. Boston Programming Center.
PROCEEDINGS OF THE 1968 SUMMER INSTITUTE ON SYMBOLIC MATHEMATICAL COMPUTATION
R. G. Tobey. Jun 69, 307p Rept nos. NASA-CR-116915, FSC69-0312
Contract NSR-34-003-039, N00014-68-C-0479
Conf- Inst. Held At Boston, 24 Jun.-16 Aug. 1968

Descriptors: *Algorithms, *Batch processing, *Conferences, *Pl/1, *Symbolic programming, Computer programs, Mathematical models.

For abstract, see STAR 0908

N71-21572/CP PC **A02** MF **A01**
Texas Univ., Austin. Applied Mechanics Research Lab.
Automated, Closed Form Integration of Formulas in Elliptic Motion
W. H. Jefferys. Aug 70, 12p Rept nos. NASA-CR-114965, AMRL-1020
Contract NGR-44-012-046

Descriptors: *Algorithms, *Computer programs, *Numerical analysis, Applications of mathematics, Integral equations, Perturbation theory.
Identifiers: NASA subject code 19.

For abstract, see STAR 0910

N71-26381/CP PC **A04** MF **A01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
An Integrator Design
F. T. Krogh. 15 May 71, 63p Rept nos. NASA-CR-118521, JPL-TM-33-479
Contract NAS7-100

Descriptors: *Differential equations, *Integrators, *Subroutines, Algorithms, Boundary value problems, Computer programs, Numerical analysis.

For abstract, see STAR 0914

N71-26527/CP PC **A02**
Royal Aircraft Establishment, Farnborough (England).
On Some Developments in the Study of Processes for Solving Ordinary Differential Equations
R. H. Merson. Aug 69, 11p Rept no. RAE-TM-SPACE-126

Descriptors: *Computer programs, *Differential equations, *Digital computers, Applications of mathematics, Numerical analysis, Problem solving.

For abstract, see STAR 0914

N71-27619/CP PC **A02**
Aeronautical Research Labs., Melbourne (Australia).
Matrix Eigenvalue Calculation by the Danilevski Method
B. Emslie, and N. B. Joyce. Apr 70, 23p Rept no. ARL/SM-349

Descriptors: *Computer programs, *Eigenvalues, *Fortran, *Matrices (mathematics), *Real numbers, Eigenvectors, Polynomials.

For abstract, see STAR 0915

N71-30579/CP PC **A02** MF **A01**
National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A Least Square Distance Curve Fitting Technique
J. Q. Howell. Jul 71, 24p Rept nos. NASA-TN-D-6354, L-7675
Contract 125-21-21-01

Descriptors: *Curve fitting, *Least squares method, *Regression analysis, Computer programs, Distance, Functional analysis.

For abstract, see STAR 0918

N71-31371/CP PC **A03** MF **A01**
National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
A Statistical Technique for Computer Identification of Outliers in Multivariate Data
R. Swaroop, and W. R. Winter. Aug 71, 30p Rept nos. NASA-TN-D-6472, H-657
Contract 127-49-20-00-24

Descriptors: *Abnormalities, *Computer programs, *Editing routines (computers), *Multivariate statistical analysis, Analogs, Data processing.

For abstract, see STAR 0918

N71-34532/CP PC **A03**/MF **A01**
National Aeronautics and Space Administration, Washington, D.C.
THEORETICAL AND APPLIED MATHEMATICS A COMPILATION
1971, 26p Rept no. NASA-SP-5939(01)

Descriptors: *Applications of mathematics, *Computer programs, *Industries, Curve fitting, Fourier transformation, Least squares method, Numerical integration.

For abstract, see STAR 0921

N71-36957/CP PC **A02**/MF **A01**
Istituto Di Fisica Dell Atmosfera, Rome (italy).
Practical Questions Regarding the Use of Mie Shock Waves for Spherical Particles . Questioni Pratiche Riguardanti Luso Della Sezione Durto di Mie Per Particelle Sferiche
R. Ferrara, and G. Tonna. 1970, 16p Rept no. IFA-CP-224
Conf- Presented At the 18th Conf. of the Assoc. Geofis. Ital., Naples, 1-4 Oct. 1969

Descriptors: *Homogeneity, *Mie scattering, *Spheres, Angular distribution, Computer programs, Isotropy, Scattering cross sections, Shock waves.

For abstract, see STAR 0923

N72-15558/CP PC **A02**/MF **A01**
Ohio State Univ., Columbus. Electroscience Lab.
The Calculation of the Eigenvalues and Eigenfunctions of Mathieus Equation
D. B. Hodge. Jan 72, 15p Rept nos. NASA-CR-1937, REPT-2902-4
Contract NGL-36-008-138

Descriptors: *Eigenvalues, *Eigenvectors, *Mathieu function, Coefficients, Computer programs, Independent variables, Recursive functions, Trigonometric functions.

For abstract, see STAR 1006

N72-15559/CP PC **A05**/MF **A01**
National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A Method for Nonlinear Exponential Regression Analysis
B. G. Junkin. 29 Oct 71, 92p Rept no. NASA-TM-X-64633

Descriptors: *Computer techniques, *Data processing, *Decay, *Nonlinear systems, *Regression analysis, Computer programs, Curve fitting, Exponential functions, Iteration, Least squares method, Taylor series.

For abstract, see STAR 1006

N72-17006/CP PC **A05**/MF **A01**
Bolt, Beranek, and Newman, Inc., Cambridge, Mass.

A Study of the Markov Game Approach to Tactical Maneuvering Problems
S. Baron, D. L. Kleinman, and S. Serbin. Feb 72, 82p Rept nos. NASA-CR-1979, REPT-2179
Contract NAS1-9910

Descriptors: *Game theory, *Markov processes, *Pilot performance, *War games, Combat, Computer programs, Computerized simulation, Cost effectiveness, Trajectory optimization.

For abstract, see STAR 1008

N72-23621/CP PC **A05**/MF **A01**
National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
Roots of Polynomials by Ratio of Successive Derivatives
J. E. Crouse, and C. W. Putt. May 72, 81p Rept nos. NASA-TN-D-6793, E-6585

Descriptors: *Complex numbers, *Polynomials, *Roots of equations, Computer programs, Problem solving.

An order of magnitude study of the ratios of successive polynomial derivatives yields information about the number of roots at an approached root point and the approximate location of a root point from a nearby point. The location approximation improves as a root is approached, so a powerful convergence procedure becomes available. These principles are developed into a computer program which finds the roots of polynomials with real number coefficients. (Author)

N72-25566/CP PC **E04**/MF **A01**
Eidgenossische Technische Hochschule, Zurich (switzerland).
A Convergent Iteration Procedure for Calculating the Roots of a Polynomial . Ein Konvergentes Interationsverfahren Zur Berechnung der Wurzeln Eines Polynoms
Ph.D. Thesis
W. Kellenberger. 1971, 108p Rept no. DISS-4653

Descriptors: *Iterative solution, *Numerical analysis, *Polynomials, *Problem solving, *Roots of equations, Algorithms, Computer programs, Numerical analysis, Theorem proving.

A convergent iteration procedure for determining the roots of a polynomial is described. The procedure is based on a practical universal algorithm. The method of Nasita-Nickel is described as the basis for the procedure followed. Several theorems are proven to illustrate the steps involved in developing the algorithm. Mathematical models are developed to support the theoretical considerations. A computer program for conducting the machine calculation of the procedure is included.

N72-33589/CP PC **A02**/MF **A01**
Netherlands Interdepartmental Working Group on the Application of Remote Sensing, Delft. Data Processing Dept.
Delft. A Programme System for Surface Approximation
E. R. Bosman, D. Eckhart, and K. Kubik. Aug 71, 23p

Descriptors: *Approximation, *Computer programs, *Earth surface, Cartesian coordinates, Computation, Polynomials, Solid surfaces.

A program system for the computation of a surface through a set of given data points is described. The program system can be applied to all those fields of science, where a surface has to be approximated, such as geology, geochemistry, cartography, engineering, and medicine. The program system, named Delft according to its place of origin, consists of a set of different modules for the computation of a surface, which have the following common properties. (1) Very flexible functions are used to analytically represent the surface. (2) The genesis of the physical surface under consideration can be modelled in the computation. The basic principles of the program modules are outlined followed by a detailed description of the computational algorithms and numerical examples. (Author)

N73-11357/CP PC **A02**/MF **A01**
Centre National de La Recherche Scientifique, Toulouse (France). Lab. Dautomatique Et de Ses Applications Spatiales.
Application of the Least Squares Method to Parameterization . Application de la Methode des Moindres Carres a la Recherche de Parametres
J. P. Gouyon. May 72, 15p Rept no. LAAS-NT-SIS-72-T-08

Descriptors: *Confidence limits, *Least squares method, *Parameterization, Computer programs, Error analysis, Estimators, Extremum values, Independent variables, Optimization, Probability theory.

For abstract, see STAR 1102

N73-12643/CP PC **A03**/MF **A01**
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Information Processing.
The Application of Two Variance-Reducing Techniques on a Queueing Simulation in Simula-67
I. J. Andreasson. 1970, 32p Rept no. NA-70-21

Descriptors: *Computerized simulation, *Queueing theory, *Sampling, *Variance (statistics), Coding, Computer programs, Monte carlo method, Statistical correlation.

Two simple methods, correlated and antithetic sampling, to reduce the variance of Monte Carlo estimates, are discussed and illustrated on a queueing problem which was coded in Simula-67. The variance reduction achieved with the two techniques was approximately a factor of 11 for correlated sampling and 1.75 for antithetic sampling. It is concluded that the cost of obtaining a given accuracy is reduced by a factor of 14. (Author)

N73-13593/CP PC **A02**/MF **A01**
Centre National de La Recherche Scientifique, Toulouse (France). Lab. Dautomtique Et de Ses Applications Spatiales.
Application of the Least Squares Method to Parameterization . Application de la Methode des Moindres Carres a la Recherche de Parametres
J. P. Gouyon. May 72, 15p Rept no. LAAS-NT-SIS-72-T-08

Descriptors: *Confidence limits, *Least squares method, *Parameterization, Computer programs, Error analysis, Estimators, Extremum values, Independent variables, Optimization, Probability theory.

A least squares method is described which determines an unknown parameter vector from measurements. This method permits identification, in the p dimension space of the vector Q of a region containing the extremity of this vector with a certain probability (95%). The problem can then be solved by means of the estimation of confidence intervals, and this method has led to the development of computer programs which can be applied to 3, 4, and 5 parameter cases. (Author)

N73-14615/CP PC **A03**/MF **A01**
Eidgenossisches Flugzeugwerk, Emmen (Switzerland).
Statistics of Extremes for Fatigue Tests
25 Aug 72, 38p Rept no. FO-1078
LANG- IN GERMAN ENGLISH SUMMARY

Descriptors: *Probability theory, *Statistical analysis, Computer programs, Failure analysis, Fatigue life.

The statistics of extremes basic theory and its use is outlined. The probability estimation of survival fatigue failures by the statistics of extremes is in good agreement with fatigue tests. A computer program for the quick evaluation of test results was established. Its description and an example are given. (Author)

N73-15223/CP PC **A03**/MF **A01**
Research Inst. of National Defence, Stockholm (Sweden).
Fortran Routines for Approximation with RI (Spline) Functions
B. Einarsson, and B. Sjoegren. Jun 71, 26p Rept no. FOA-2-C-2476-11
Language Swedish

Descriptors: *Fortran, *Spline functions, Computer programs, Input/output routines, Interpolation.

Computer routines were developed for interpolation and integration where approximation with cubic splines are included. These routines were applied to varied programs. (Author)

N73-17181/CP PC **A12**/MF **A01**
Memphis State Univ., Tenn.
Computer Programs for the Solution of Systems of Linear Algebraic Equations
W. T. Sequi. Jan 73, 251p Rept no. NASA-CR-2173
Contract NCA8-44

Descriptors: *Computer programs, *Linear equations, Finite element method, Fortran, Matrices (mathematics), Simultaneous equations.
Identifiers: NASA.

FORTRAN subprograms for the solution of systems of linear algebraic equations are described, listed, and evaluated in this report. Procedures considered are direct solution, iteration, and matrix inversion. Both incore methods and those which utilize auxiliary data storage devices are considered. Some of the subroutines evaluated require the entire coefficient matrix to be in core, whereas others account for banding or sparceness of the system. General recommendations relative to equation solving are made, and on the basis of tests, specific subprograms are recommended. (Author)

N73-18201/CP PC **A03**/MF **A01**
National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
Poolms a Computer Program for Fitting and Model Selection for Two Level Factorial Replication-Free Experiments
G. E. Amling, and A. G. Holms. Feb 73, 29p Rept nos. NASA-TM-X-2706, E-7142

Descriptors: *Computer programs, *Factorial design, Mathematical models, Probability theory, Regression analysis, Root-mean-square errors, Statistical decision theory.
Identifiers: NASA.

A computer program is described that performs a statistical multiple-decision procedure called chain pooling. It uses a number of mean squares assigned to error variance that is conditioned on the relative magnitudes of the mean squares. The model selection is done according to user-specified levels of type 1 or type 2 error probabilities. (Author)

N73-23655/CP PC **A03**/MF **A01**
Vrije Universiteit, Brussels (Belgium). Dept. of Fluid Mechanics.
Computation of Individual Charcteristic Values and Associated Solutions of Mathieus Equation
C. Hirsch. Nov 72, 42p Rept no. VUB-STR-1

Descriptors: *Computer programs, *Mathieu function, *Problem solving, Eigenvalues, Eigenvectors, Numerical analysis.
Identifiers: NASA.

A computer program is developed which enables the computation of a characteristic value of arbitrary order of Mathieu's equation and the associated solution without the prior calculation of all characteristic values of lower order. The maximum order is 150 and the parameter Q of Mathieu's equation may range up to 10,000. The method is based on the numerical techniques for evaluation of Mathieu functions and characteristic values. The FORTRAN listings are given as well as numerical examples. (Author)

N73-25650/CP PC **A03**/MF **A01**
Cincinnati Univ., Ohio.
An Algorithm for Generating All Possible 2(P-Q) Fractional Factorial Designs and Its Use in Scientific Experimentation
S. M. Sidik. Jun 73, 33p Rept nos. NASA-TN-D-7327, E-7365

Descriptors: *Algorithms, *Computer programs, *Factorial design, Analysis of variance, Bayes theorem, Optimization.
Identifiers: NASA.

For abstract, see STAR 1116

N73-26617/3CP PC **E03**/MF **A01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
Sparse Matrix Methods Based on Orthogonality and Conjugacy
C. L. Lawson. 15 Jun 73, 66p Rept nos. NASA-CR-133231, JPL-TM-33-627
Contract NAS7-100

Descriptors: *Conjugation, *Matrices (Mathematics), *Orthogonal functions, Algorithms, Computer programs, Least squares method, Linear equations.
Identifiers: NASA.

A matrix having a high percentage of zero elements is called spares. In the solution of systems of linear equations or linear least squares problems involving large sparse matrices, significant saving of computer cost can be achieved by taking advantage of the sparsity. The conjugate gradient algorithm and a set of related algorithms are described. (Author)

N73-30995/7CP PC **A03**/MF **A01**
Behavioral Technology Consultants, Silver Spring, Md.
Statistical Evaluation of Time Series Analysis Techniques
V. A. Benignus. Jun 73, 47p Rept no. NASA-CR-134011
Contract NAS9-12902

Descriptors: *Computer programs, *Multivariate statistical analysis, *Spectrum analysis, Fast fourier transformations, Monte carlo method, Nasa programs, Performance.
Identifiers: NASA.

The performance of a modified version of NASA's multivariate spectrum analysis program is discussed. A multiple regression model was used to make the revisions. Performance improvements were documented and compared to the standard fast Fourier transform by Monte Carlo techniques.

N73-31550/9CP PC **A05**/MF **A01**
Rice Univ., Houston, Tex. Inst. for Computer Services and Applications.
The Use of the Modified Cholesky Decomposition in Divergence and Classification Calculations
D. L. Vanrooy, M. S. Lynn, and C. H. Snyder. May 73, 80p Rept nos. NASA-CR-133990, ICSA-275-025-008
Contract NAS9-12776

Descriptors: *Algorithms, *Computer programs, *Remote sensors, Flow charts, Fortran, Numerical analysis, Statistical analysis.
Identifiers: NASA.

The use of the Cholesky decomposition technique is analyzed as applied to the feature selection and classification algorithms used in the analysis of remote sensing data (e.g. as in LARSYS). This technique is approximately 30% faster in classification and a factor of 2-3 faster in divergence, as compared with LARSYS. Also numerical stability and accuracy are slightly improved. Other methods necessary to deal with numerical stablity problems are briefly discussed. (Author)

N73-32487/3CP PC **E04**/MF **A01**
National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A Comparison of Digital Computer Programs for the Numerical Solution of Ordinary Differential Equations
H. L. Ingram. 1 Jul 73, 108p Rept no. NASA-TM-X-64781

Descriptors: *Computer programs, *Differential equations, *Digital computers, Algorithms, Numerical analysis, Taylor series, Trajectory optimization.
Identifiers: NASA.

Recently the determination of the best technique for numerically solving systems of ordinary differential equations on a digital computer has received much attention. The use of these formulas in conjunction with a stepsize control developed is explained, and one of the formulas is chosen for comparison with other integration techniques. This comparison of one of the best of Fehlberg's formulas with the different numerical techniques described in previous studies on a variety of test problems clearly shows the superiority of Fehlberg's formula. That is, on each of the test problems, the chosen Fehlberg formula is able to achieve a given accuracy in less computer time than any of the other techniques tested. Also, the computer program for the chosen Fehlberg formula is less complex and easier to use than the computer programs for most of the other techniques. To illustrate the use of the chosen Fehlberg formula, a computer listing of its application to several example problems is included along with a sample of the computer output from these applications. (Author)

N73-33518/4CP PC **A03**/MF **A01**
Royal Aircraft Establishment, Farnborough (England). Structures Dept.
The Prediction of Instabilities of Linear Differential Equations with Periodic Coefficients
R. J. Davies. 1973, 34p Rept nos. ARC-R/M-3713, RAE-TM-STRUCT-794
Misc-Supersedes Rae-TM-Struct-794; Arc-33260; Rae-TR-67161; Arc-29.

Descriptors: *Differential equations, *Linear equations, *Periodic functions, *Systems stability, Coefficients, Computer programs, Floquet theorem, Rigid rotors.
Identifiers: NASA.

The stability of the solutions of a system of differential equations with periodic coefficients has been examined using Floquet's theorem and a general method of solution has been programmed in ICL 1900 FORTRAN. The application of the method is illustrated by the solution of two dynamical systems, both of which are unsymmetrical rigid rotors in unsymmetrical bearings, and the program has been used to obtain solutions for up to six simultaneous second-order differential equations with periodic coefficients. (Author)

N74-10562/8CP PC **A03**/MF **A01**
Analytical Mechanics Associates, Inc., Jericho, N.Y.
A Computer Program to Calculate Zeroes, Extrema, and Interval Integrals for the Associated Legendre Functions
M. H. Payne. Apr 73, 45p Rept nos. NASA-CR-132838, REPT-73-19
Contract NAS5-21787

Descriptors: *Computer programs, *Geopotential, *Legendre functions, *Spherical harmonics, Digits, Mathematical models, Truncation errors.
Identifiers: NASA.

A computer program is described for the calculation of the zeroes of the associated Legendre functions, Pnm, and their derivatives, for the calculation of the extrema of Pnm and also the integral between pairs of successive zeroes. The program has been run for all n,m from (0,0) to (20,20) and selected cases beyond that for n up to 40. Up to (20,20), the program (written in double precision) retains nearly full accuracy, and indications are that up to (40,40) there is still sufficient precision (4-5 decimal digits for a 54-bit mantissa) for estimation of various bounds and errors involved in geopotential modelling, the purpose for which the program was written. (Author)

N74-13288/7CP PC **A02**/MF **A01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
A Proposal for Standard Linear Algebra Subprograms
R. J. Hanson, F. T. Krogh, and C. L. Lawson. 15 Nov 73, 19p Rept nos. NASA-CR-136216, JPL-TM-33-660
Contract NAS7-100

Descriptors: *Computer programs, *Fortran, Algebra, Linear equations, Subroutines.
Identifiers: NASA.

A set of FORTRAN callable subprograms are proposed which will be useful in the development of efficient portable ANSI FORTRAN subprograms and applications programs in the area of linear algebra. (Author)

N74-14254/8CP PC **A06**/MF **A01**
National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
Multiple Regression Technique for Pth Degree Polynominals with and Without Linear Cross Products
J. W. Davis. Dec 73, 107p Rept nos. NASA-TN-D-7422, M-109

Descriptors: *Polynomials, *Regression analysis, Computer programs, Linear equations, Mathematical models.
Identifiers: NASA.

A multiple regression technique was developed by which the nonlinear behavior of specified independent variables can be related to a given dependent variable. The polynomial expression can be of Pth degree and can incorporate N independent variables. Two cases are treated such that mathematical models can be studied both with and without linear cross products. The resulting surface fits can be used to summarize trends for a given phenomenon and provide a mathematical relationship for subsequent analysis. To implement this technique, separate computer programs were developed for the case without linear cross products and for the case incorporating such cross products which evaluate the various constants in the model regression equation. In addition, the significance of the estimated regression equation is considered and the standard deviation, the F statistic, the maximum absolute percent error, and the average of the absolute values of the percent of error evaluated. The computer programs and their manner of utilization are described. Sample problems are included to illustrate the use and capability of the technique which show the output formats and typical plots comparing computer results to each set of input data. (Author)

N74-15307/3CP PC **A02**/MF **A01**
National Physical Lab., Teddington (England). Div. of Numerical Analysis and Computing.
Available Algorithms for Curve and Surface Fitting
J. G. Hayes. Jul 73, 24p Rept no. NPL-NAC-39
Conf-Presented at the Ima Conf. On Software for Numerical Math., Loughborough, Engl., Apr. 1973.

Descriptors: *Algorithms, *Curve fitting, *Data smoothing, Computer programs, Least squares method, Linearity, Polynomials, Spline functions.
Identifiers: NASA.

Available numerical algorithms for a wide range of curve and surface fitting problems are surveyed. Fitting in the least squares norm with both linear and nonlinear functions is included, with particular attention being paid to polynomial and spline curves and surfaces. Attention is also given to the question of imposing linear constraints on the solutions.

N74-15308/1CP PC **A03**/MF **A01**
National Physical Lab., Teddington (England). Div. of Numerical Analysis and Computing.
A Data-Fitting Package for the Non-Specialist User
M. G. Cox. Jul 73, 28p Rept no. NPL-NAC-40
Subm-Submitted for Publication.

Descriptors: *Computer programs, *Data smoothing, *Spline functions, Algorithms, Approximation, Polynomials.
Identifiers: NASA.

A polynomial and spline data-fitting package, written in the form of a suite of ALGOL 60 procedures, is described. The package includes algorithms for providing approximations to data which may be tabular, graphical, or mathematical. Also included are algorithms for evaluating, differentiating, and integrating the approximation concerned.

N74-23156/4CP PC **A03**/MF **A01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
A Comparison of Computational Methods and Algorithms for the Complex gamma Function.
E. W. Ng. 1 May 74, 27p Rept nos. NASA-CR-138457, JPL-TM-33-686
Contract NAS7-100

Descriptors: *Algorithms, *Gamma function, Chebyshev approximation, Computer programs, Methodology, Pade approximation, Stirling cycle, Subroutine libraries (Computers), Truncation errors.

A survey and comparison of some computational methods and algorithms for gamma and log-gamma functions of complex arguments are presented. Methods and algorithms reported include Chebyshev approximations, Pade expansion and Stirling's asymptotic series. The comparison leads to the conclusion that Algorithm 421 published in the Communications of ACM by H. Kuki is the best program either for individual application or for the inclusion in subroutine libraries. (Author)

N74-30550/9CP PC **A02**/MF **A01**
Rice Univ., Houston, Tex. Dept. of Economics and Mathematical Sciences.
Finite Pure Integer Programming Algorithms Employing Only Hyperspherically Deduced Cuts.
Final Report.
R. D. Young. 3 May 71, 25p Rept no. NASA-CR-139561
Contract NGR-44-006-128

Descriptors: *Algorithms, *Computer programming, *Hyperspheres, *Integers, Analysis (Mathematics), Computer programs, Hyperplanes, Set theory.

Three algorithms are developed that may be based exclusively on hyperspherically deduced cuts. The algorithms only apply, therefore, to problems structured so that these cuts are valid. The algorithms are shown to be finite. (Author)

N74-32039/1CP PC **A05**/MF **A01**
North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.
Surface Fitting Three-Dimensional Bodies.
Final Report, May 1973 - Jul. 1974.
F. R. Dejarnette. Jul 74, 82p Rept no. NASA-CR-139663
Contract NGR-34-002-193

Descriptors: *Computer programs, *Curve fitting, *Surfaces, Cross sections, Curvature, Delta wings, Mathematical models.

The geometry of general three-dimensional bodies is generated from coordinates of points in several cross sections. Since these points may not be smooth, they are divided into segments and general conic sections are curve fit in a least-squares sense to each segment of a cross section. The conic sections are then blended in the longitudinal direction by fitting parametric cubic-spline curves through coordinate points which define the conic sections in the cross-sectional planes. Both the cross-sectional and longitudinal curves may be modified by specifying particular segments as straight lines and slopes at selected points. Slopes may be continuous or discontinuous and finite or infinite. After a satisfactory surface fit has been obtained, cards may be punched with the data necessary to form a geometry subroutine package for use in other computer programs. At any position on the body, coordinates, slopes and second partial derivatives are calculated. The method is applied to a blunted 70 deg delta wing, and it was found to generate the geometry very well. (Author)

N74-32045/8CP PC **A04**/MF **A01**
National Physical Lab., Teddington (England). Div. of Numerical Analysis and Computing.
Curve Fitting: A Guide and Suite of Algorithms for the Non-Specialist User.
M. S. Cox, and J. G. Hayes. Dec 73, 57p Rept no. NPL-NAC-26

Descriptors: *Algorithms, *Computer programs, *Curve fitting, *Polynomials, *Spline functions, Algol, Fortran, Weighting functions.

A set of basic curve fitting algorithms is presented, written in ALGOL 60, together with detailed recommendations and advice on their use. Its aim is to provide a unified system which will enable the non-specialist user to deal with most curve fitting problems which arise in practice. The methods are based on the use of polynomials and cubic splines, and deal with data given either as a set of points or as a graph. FORTRAN versions of the algorithms were also prepared. (Author)

N74-33711/4CP PC **A04**/MF **A01**
National Physical Lab., Teddington (England). Div. of Mechanical and Optical Metrology.
Calculation of the Flatness of Surfaces: A Least-Squares Approach.
K. G. Birch, and M. G. Cox. Dec 73, 51p Rept no. NPL-MOM-5

Descriptors: *Computer programs, *Flat surfaces, *Least squares method, Algol, Contours, Function generators.

Details of computer programs, are presented with instructions to operate those programs, that will enable the departure from flatness of a surface to be calculated. The input data to the computer programs are measurements made along a series of generators on the surface by any one of a number of instruments that indicate relative height at points on the surface. The output from the computer can be in the form of a grid of surface heights denoting departures from flatness, the surface being arranged to be at a height and orientation that brings it into alignment with one of several reference surfaces. It is further possible to change the computer output to correspond to other reference surfaces, by means of a supplementary program, without repeating the complete calculation. The computer programs are written in ALGOL 60 for the KDF9 computer. (Author)

N74-33714/8CP PC **A06**/MF **A01**
Genoa Univ. (Italy). Ist. di Elettrotecnica.
Study on the Use of the Fast Fourier Transform in Spectral Analysis, Volume 3.
F. Bertora, C. Braccini, G. Gambardella, and G. Musso. 1973, 121p Rept no. ESRO-CR(P)-469
Contract ESOC-486/73-T
Seri-3.

Descriptors: *Algorithms, *Fast fourier transformations, *Spectrum analysis, *User manuals (Computer programs), Computer programs, Fortran.

A software package, consisting of a SPECAN program developed to perform spectral analysis according to the user's requirements, and other routines that can be used to perform single tasks in particular ways, is presented. This version of the program SPECAN is relatively simple and does not make use of advanced programming features. The whole package is written in a low-level FORTRAN language, except for a version of the subroutine FFTNS performing a particular FFT algorithm, that is written in the assembler language of the C2-10070 computer to maximize efficiency.

N74-34986/1CP PC **A06**/MF **A01**
National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
Program for the Analysis of Time Series.
T. J. Brown, C. G. Brown, and J. C. Hardin. Sep 74, 118p Rept nos. NASA-TM-X-2988, L-9278

Descriptors: *Algorithms, *Computer programs, *Fourier transformation, *Time series analysis, Digital data, Flow charts, Fortran, Fourier analysis, Histograms, Power spectra, Transfer functions.

A digital computer program for the Fourier analysis of discrete time data is described. The program was designed to handle multiple channels of digitized data on general purpose computer systems. It is written, primarily, in a version of FORTRAN 2 currently in use on CDC 6000 series computers. Some small portions are written in CDC COMPASS, an assembler level code. However, functional descriptions of these portions are provided so that the program may be adapted for use on any facility possessing a FORTRAN compiler and random-access capability. Properly formatted digital data are windowed and analyzed by means of a fast Fourier transform algorithm to generate the following functions: (1) auto and/or cross power spectra, (2) autocorrelations and/or cross correlations, (3) Fourier coefficients, (4) coherence functions, (5) transfer functions, and (6) histograms. (Author)

N74-34989/5CP PC **A04**/MF **A01**
National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A Vector-Dyadic Development of the Equations of Motion for n-Coupled Rigid Bodies and Point Masses.
H. P. Frisch. Oct 74, 68p Rept nos. NASA-TN-D-7767, G-7435

Descriptors: *Equations of motion, *Rigid structures, *Vector analysis, Computer programs, Digital computers, Kinematics, Orbit calculation, Satellite attitude control, Spacecraft guidance, Spacecraft stability, Torque.

The equations of motion are derived, in vector-dyadic format, for a topological tree of coupled rigid bodies, point masses, and symmetrical momentum wheels. These equations were programmed, and form the basis for the general-purpose digital computer program N-BOD. A complete derivation of the equations of motion is included along with a description of the methods used for kinematics, constraint elimination, and for the inclusion of nongyroscope forces and torques acting external or internal to the system. (Author)

N75-10736/7CP PC **A05**/MF **A01**
Appalachian State Univ., Boone, N.C. Dept. of Mathematical Sciences.
An Empirical Analysis of the Distribution of Overshoots in a Stationary Gaussian Stochastic Process.
M. C. Carter, and M. W. Madison. Jul 73, 84p Rept nos. NASA-CR-129008, TR-2
Contract NAS8-29286

Descriptors: *Normal density functions, *Statistical distributions, *Stochastic processes, Computer programs, Computerized simulation, Statistical analysis, Tables (Data), Temperature distribution, Wind velocity measurement.

The frequency distribution of overshoots in a stationary Gaussian stochastic process is analyzed. The primary processes involved in this analysis are computer simulation and statistical estimation. Computer simulation is used to simulate stationary Gaussian stochastic processes that have selected autocorrelation functions. An analysis of the simulation results reveals a frequency distribution for overshoots with a functional dependence on the mean and variance of the process. Statistical estimation is then used to estimate the mean and variance of a process. It is shown that for an autocorrelation function, the mean and the variance for the number of overshoots, a frequency distribution for overshoots can be estimated. (Author)

N75-12676/3CP PC **A02**/MF **A01**
Research Inst. of National Defence, Stockholm (Sweden).
The Automatic Computation of the Coefficients in a Class of Modified Multistep Methods.
G. Bjurel. Nov 72, 15p Rept no. FOA-2-C-2571-M4

Descriptors: *Coefficients, *Computation, *Computer programs, Differential equations.

A method and a computer program are described for the computation of coefficients in a class of modified multistep methods intended for the solution of stiff ordinary differential equations. (Author)

N75-13566/5CP PC **A03**/MF **A01**
Toronto Univ. (Ontario). Dept. of Computer Science.
A Structure for Programs That Solve Ordinary Differential Equations.
T. E. Hull, and W. H. Enright. May 74, 41p Rept no. TR-66
Subm-Sponsored by Natl. Res. Council of Can.

Descriptors: *Computer programs, *Differential equations, *Numerical analysis, Fortran, Subroutines, User manuals (Computer programs).

A structure for programs that solve initial value problems associated with ordinary differential equations is described. A particular parameter list is proposed, and an overall structure for the program itself is described in terms of four stages of the numerical process. The ideas are applicable to a wide variety of methods, and contribute to some standardization. An example based on formulas due to Fehlberg is presented in an appendix, along with a detailed discussion of the design decisions for this particular method. The resulting program is reasonably reliable and efficient. (Author)

N75-18008/3CP PC **A03**/MF **A01**
National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala. Dept. of Mathematical Sciences.
The Effects of Correlation on Goodness of Fit.
L. J. Kitchens. 6 Jan 75, 38p Rept no. NASA-CR-120610
Contract NAS8-29286

Descriptors: *Autocorrelation, *Computer programs, *Statistical analysis, Kolmogoroff-smirnoff test, Linear transformations, Regression analysis.

Autocorrelated normal random variates were generated via computer and the effects of various levels of correlation on goodness of fit problems were studied. The results are useful in determining the distribution or estimating the parameters of populations that correlate observations such as wind speeds and temperature. The model used to generate the autocorrelated data is an autoregressive process of order 1. The Kolmogorov-Smirnov and chi-square statistics are used in the analysis. It was observed in the simulation that high positive correlations tend to shift the sample mean away from the population mean and negative correlations tend to shift the sample mean towards the population mean. In many cases, it was observed that positive and negative correlations tend to decrease the standard deviation. However, since this did not occur in all cases, no definite conclusion can be made regarding the standard deviation. Since the autoregressive process is a linear transformation, it is not surprising that normality was preserved. However, a possible extension of this problem could be to generate non-normal data and observe how the distribution is affected by correlation. Another extension might utilize another model such as autoregressive of order k or a moving average process of order k. (Author)

N75-22029/3CP PC **A07**/MF **A01**
Behavioral Technology Consultants, Silver Spring, Md.
Statistical Evaluation of Time Series Analysis Techniques. Volume 2: appendices.
Final Report.
Jun 73, 126p Rept no. NASA-CR-134012
Contract NAS9-12902

Descriptors: *Computer programs, *Input/output routines, *Multivariate statistical analysis, *Spectrum analysis, Fast fourier transformations, Monte carlo method, Nasa programs, Numerical analysis.

For abstract, see STAR 1313

N75-25651/1CP PC **A02**/MF **A01**
National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
An Algorithm and Computer Program to Locate Real Zeros of Real Polynomials.
D. R. Hedgley, Jr. Jun 75, 24p Rept nos. NASA-TN-D-8009, H-855

Descriptors: *Algorithms, *Computer programs, *Polynomials, *Real numbers, Digital computers, Fortran, Laguerre functions, Newton-raphson method, Numerical analysis, Trigonometric functions.

A method for reliably extracting real zeros of real polynomials using an expanded two-point secant and bisection method is formed into an algorithm for a digital computer, and a computer program based on this algorithm is presented. The results obtained with the program show that the proposed method compares favorably with the Laguerre, Newton-Raphson, and Jenkins-Traub methods when the polynomial has all real zeros, and is more efficient when the polynomial has complex zeros. (Author)

N75-29856/2CP PC **A04**/MF **A01**
Kanner (Leo) Associates, Redwood City, Calif.
Allocation Methodology. Distance Determinations and Population Catchment Determinations, and Their Applicability to Practical Planning.
A. Roennberg, O. Salomonsson, and K. Selander. Aug 75, 65p Rept nos. NASA-TT-F-16495, NIMS-3
Tran-Transl. Into English from the Swedish Report Nims-3.

Descriptors: *Allocations, *Distance, *Information systems, *Populations, *Urban planning, Cities, Computer programs, Highways, Land use, Streets, Urban transportation.

Geographic areas are delimited from given starting points (often some form of service outlet) and retrieval of their contents is carried out for both distance-determined areas and population catchment areas. The applications are carried out with the Flows in Networks analysis system. (Author)

N76-11755/5CP PC **A02**/MF **A01**
Loughborough Univ. of Technology (England). Dept. of Mathematics.
A Note on an Algorithm for Generating Bessel Functions of Integer and Half Order.
G. A. Evans. Feb 75, 11p Rept no. MATHS-RES-53

Descriptors: *Algorithms, *Bessel functions, *Function generators, Algol, Computer programs.

An approach is made to develop an algorithm for generating Bessel functions Jn(z) and spherical Bessel function jn(z) for a wide range of both n and z. The problem of the unstable recurrence relation for higher order functions is considered using this relation in reverse. The proposed algorithm calculates n so that the required accuracy can be obtained in a single sweep of the reverse iteration.

N76-20861/0CP PC **A02**/MF **A01**
Houston Univ., Tex. Dept. of Mathematics.
Uhmle: Program Description User Guide.
W. A. Cobely, and C. L. Wiginton. Oct 75, 21p Rept nos. NASA-CR-147520, REPT-48
Contract NAS9-12777

Descriptors: *Computation, *Maximum likelihood estimates, *Normal density functions, *User manuals (Computer programs), Covariance, Iterative solution, Matrices (Mathematics), Set theory.
Identifiers: UHMLE computer program.

A program which computes maximum likelihood estimates for the general normal mixture is introduced. The program allows the user to fix any subsets of the mixture parameters; this fixed set may be redefined at various times in the iteration process. There is considerable time saved in computing the likelihoods if the diagonal form is specified. Hence, in the early iterations the diagonal assumption might be used, changing over to the full covariance mode later in the iteration process for a more refined solution. This flexibility allows the user to choose the sequence of parameter configurations in the iteration process which he feels will optimize the computation time required as well as possibly avoid convergence to suboptimal local maxima of the likelihood function. (Author)

N76-22225/6CP PC **A05**/MF **A01**
Lockheed Electronics Co., Houston, Tex. Aerospace Systems Div.
Set Covering Algorithm, a Subprogram of the Scheduling Algorithm for Mission Planning and Logistic Evaluation.
H. Chang. Mar 76, 79p Rept nos. NASA-CR-147551, LEC-6842
Contract NAS9-12200

Descriptors: *Algorithms, *Computer programs, *Logistics management, *Mission planning, *Scheduling, Input/output routines, Mathematical models, Optimization, Traffic.

A computer program using Lemke, Salkin and Spielberg's Set Covering Algorithm (SCA) to optimize a traffic model problem in the Scheduling Algorithm for Mission Planning and Logistics Evaluation (SAMPLE) was documented. SCA forms a submodule of SAMPLE and provides for input and output, subroutines, and an interactive feature for performing the optimization and arranging the results in a readily understandable form for output. (Author)

N76-22951/7CP PC **A02**/MF **A01**
Telecom Australia Research Labs., Melbourne.
Computation of Characteristic Values of Non-Symmetric Matrices.
L. A. Denger. Feb 75, 23p Rept no. REPT-6966

Descriptors: *Eigenvalues, *Eigenvectors, *Matrices (Mathematics), Algorithms, Basic (Programming language), Computer programs, Minicomputers.
Identifiers: Australia.

An algorithm for computing the characteristic values of nonsymmetric matrices by minicomputers in BASIC language was investigated. Starting from the QR method, it was found that a simple resolving matrix can be computed, leading to more accurate results. The Main results are that Hessenberg transformations reduced to a matrix operation; the simple diagonalization process led to more accurate results; and, in some cases and indirectly, the deflation process can improve the accuracy. (Author)

N76-23920/1CP PC **A03**/MF **A01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
C Super 1: Compatible Interpolation over a Triangle.
C. L. Lawson. 1 May 76, 39p Rept nos. NASA-CR-147946, JPL-TM-33-770
Contract NAS7-100

Descriptors: *Applications of mathematics, *Computer programming, *Interpolation, Algorithms, Computer programs, Numerical analysis.

An elementary derivation and a complete description is given of an algorithm for interpolation over a plane triangle when function values and first partial derivatives are given at the vertices. The method gives C1 continuity with neighboring triangles. The interpolation method is mathematically equivalent to one that has been discussed previously in the literature; however, the algorithmic form given here is more efficient than has previously been described. (Author)

N76-26897/8CP PC **A03**/MF **A01**
Weapons Research Establishment, Salisbury (Australia).
Powit: A Program for Solving Non-Linear Algebraic Equations.
C. A. J. Fletcher. Jun 75, 49p Rept no. WRE-TN-1431(WR/D)

Descriptors: *Computer programs, Algebra, Algorithms, Differential equations, Fortran, Numerical analysis, Printouts.
Identifiers: *POWIT computer program, Computations, *Nonlinear algebraic equations, Australia.

Methods for solving general nonlinear algebraic equations, by minimizing a sum of squared residuals, are reviewed. One method, based on Powell's (1965) algorithm, is described in detail. This method has been incorporated into a computer program, subroutine POWIT, which is written in FORTRAN 4 to suit an IBM 7090; a listing is included. Essentially the same code has been used on a CDC 6400, a CDC 6600 and a CDC 7600. POWIT is suitable for solving equations with up to 20 unkowns and is also applicable to situations where the algebraic relations are not given explicitly but result from, say, the integration of ordinary differential equations. Numerical results are given for the application of POWIT to four 'standard' test problems and to oblique shock reflection and the results indicate that POWIT is stable and considerably faster than any other method available. (Author)

N76-27904/1CP PC **A03**/MF **A01**
Rice Univ., Houston, Tex. Inst. for Computer Services and Applications.
The Recursive Maximum Likelihood Proportion Estimator: User'S Guide and Test Results.
D. L. Vanrooy. Jun 76, 27p Rept nos. NASA-CR-147824, ICSA-TR-275-025-028
Contract NAS9-12776

Descriptors: *Maximum likelihood estimates, *Recursive functions, *User manuals (Computer programs), Algorithms, Computer programming, Data processing, Ibm 360 computer, Imagery.
Identifiers: IBM-360/67 computers.

Implementation of the recursive maximum likelihood proportion estimator is described. A user's guide to programs as they currently exist on the IBM 360/67 at LARS, Purdue is included, and test results on LANDSAT data are described. On Hill County data, the algorithm yields results comparable to the standard maximum likelihood proportion estimator. (Author)

N76-27908/2CP PC **A02**/MF **A01**
Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. fuer Dynamik der Flugsysteme.
Description of the Program Fmfpj for Minimizing a Function Subject to Constraints.
N. Engersbach. 25 Aug 75, 16p Rept no. DLR-IB-552-75/6

Descriptors: *Computer programming, *Functions (Mathematics), *Optimization, Algorithms, Constraints, Convergence.
Identifiers: FMFPJ computer program, West Germany.

The Functions Minimization using Fletcher Powell and Projection program (FMFPJ), used for solving finite dimensional function minimization problems subject to equality and inequality constraints is described. The method of solution contains the fast convergence properties of the Davidon Fletcher Powell algorithms with the concept of gradient projection to treat constraints.

N76-27943/9CP PC **A03**/MF **A01**
Rice Univ., Houston, Tex. Inst. for Computer Services and Applications.
A Quasi-Newton Approach to Optimization Problems with Probability Density Constraints.
R. A. Tapia, and D. L. Vanrooy. Jun 76, 41p Rept nos. NASA-CR-147825, ICSA-TR-275-025-029
Contract NAS9-12776

Descriptors: *Mathematical programming, *Optimization, Probability density functions, Problem solving, Algorithms, Printouts, User manuals (Computer programs), Variable.

A quasi-Newton method is presented for minimizing a nonlinear function while constraining the variables to be nonnegative and sum to one. The nonnegativity constraints were eliminated by working with the squares of the variables and the resulting problem was solved using Tapia's general theory of quasi-Newton methods for constrained optimization. A user's guide for a computer program implementing this algorithm is provided. (Author)

N76-31934/2CP PC **A04**/MF **A01**
National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
Recursive Partitioned Inversion of Large (1500 X 1500) Symmetric Matrices.
B. H. Putney, J. E. Brownd, and R. A. Gomez. Jul 76, 52p Rept nos. NASA-TM-X-71181, X-921-76-160
Subm-Submitted for Publication.

Descriptors: *Algorithms, *Matrices (Mathematics), *Computer programming, Inversions, Recursive functions, Geodesy, Normal density functions, Step functions.
Identifiers: SOLVE computer program, Computations.

A recursive algorithm was designed to invert large, dense, symmetric, positive definite matrices using small amounts of computer core, i.e., a small fraction of the core needed to store the complete matrix. The described algorithm is a generalized Gaussian elimination technique. Other algorithms are also discussed for the Cholesky decomposition and step inversion techniques. The purpose of the inversion algorithm is to solve large linear systems of normal equations generated by working geodetic problems. The algorithm was incorporated into a computer program called SOLVE. In the past the SOLVE program has been used in obtaining solutions published as the Goddard earth models. (Author)

N76-33876/3CP Not available NTIS
Kernforschungszentrum, Karlsruhe (West Germany).
Ipol: A Fortran Routine for Two Dimensional Interpolation.
C. Guenther. Nov 75, 32p Rept no. KFK-2175
Language in German.

Descriptors: *Computer programming, *Interpolation, *Polynomials, Fortran, Linear programming, Numerical integration, Set theory, Two dimensional bodies.
Identifiers: West Germany, *IPOL computer program.

Let a set of N real points, (x/sub i/, y/sub i/), i = 1, 2, ..., N, be given. The FORTRAN subroutine IPOL calculates a maximum number v greater than or equal to 1 of linearly independent polynominals, P sub 1 (x,y), ..., P/sub v/(x,y), which are of least possible degree g and which have the (x/sub i/, y/sub i/) as zeros, P/sub K/(x/sub i/, y/sub i/) = O for i = 1, 2, ..., N and K = 1, ..., v. IPOL is used to find polynominals P(x,y) vanishing in a given point set. This is done by setting P(x,y): = P sub 1 (x,y) if v = 1, and if v 1 by taking a suitable linear combination of P sub 1 (x,y), ..., P/sub v/(x,y). An example is given for a multivariate interpolation problem. In addition, an aspect of numerical integration can be clarified by the use of IPOL. For some quadrature formulas of polynominal degree 2l-1 in two dimensions, the number of linearly independent polynominals of degree l which have the points of these formulas as zeros is given. (Author)

N77-10407/3CP PC **A03**/MF **A01**
Technical Univ. of Denmark, Lyngby. Inst. of Electromagnetics.
Programs for Computation of Mathieu Functions.
T. Larsen. Mar 75, 43p Rept nos. TUD-S-265, TUD-R-137

Descriptors: *Computer programs, *Mathieu function, *Waveguides, Elliptical cylinders, Fortran, Subroutines.
Identifiers: Denmark.

A number of subroutines written in FORTRAN 4 to compute ordinary and modified Mathieu functions are described. A simpler and less accurate program for the computation of ordinary Mathieu functions is included. The programs were written for use in connection with investigations on waveguides with elliptical cross sections.

N77-10844/7CP PC **A03**/MF **A01**
Technical Univ. of Denmark, Lyngby. Inst. of Electromagnetics.
Fortran Subroutines for Non-Linear Minimax Optimization.
K. Madsen, and H. Schjaer-jacobsen. Feb 75, 29p Rept no. TUD-R-135

Descriptors: *Computerized design, *Minimax technique, *Subroutine libraries (Computers), Algorithms, Network synthesis, Convergence, Fortran, Ibm 360 computer, Nonlinear equations, Optimization, Packages.
Identifiers: Denmark, IBM-360/165 computers, FORTRAN 4 programming language, MINIM1 computer program, MINIM2 computer program.

A user-oriented description of two new nonlinear minimax optimization program packages, MINIM1 and MINIM2, is given. The MINIM1 program requires evaluation of the first partial derivatives of the residual functions whereas MINIM2 does not. The usage of the packages is demonstrated by a simple example. The programs have been implemented in double precision FORTRAN 4 on an IBM 370/165 computer. It is shown that the user is able to formulate and solve the general nonlinear minimax design problem either by using gradient information (MINIM1) or without gradients (MINIM2). (Author)

N77-13760/2CP PC **A02**
Houston Univ., Tex. Dept. of Mathematics.
Program Documentation: B-Average Bhattacharyya Distance.
S. K. Marani. Aug 76, 11p Rept nos. NASA-CR-151132, REPT-57
Contract NAS9-15000

Descriptors: *Computer systems programs, *Distance, *User manuals (Computer programs), Computer programs, Fortran, Transformations (Mathematics), Univac 1108 computer.
Identifiers: Bhattacharyya theorem.

The total Bhattacharyya distance is calculated using all N channels. The output of this subroutine is used to construct the B matrix using one or two Householder transformations. FORTRAN calling sequences are given.

N77-21913/7CP PC **A05**/MF **A01**
Grenoble Univ. (France). Lab. de Mathematiques Appliquees.
Development of Smoothing Spline Functions for Telemetry Data. Volume 3: Programs and Numerical Results Etude du Developpement des Fonctions-Spline de Lissage pour des Donnees de Telemesure. Volume 3 (Programmes et Resultats Numeriques).
C. Dicrescenzo. Dec 76, 92p Rept no. ESA-CR(P)-901-V-3
Contract ESOC-553/73-AR
Seri-3.
Language in French.

Descriptors: *Computer programs, *Data smoothing, *Spline functions, *Telemetry, Algorithms, Convexity, Fortran, Inequalities, Interpolation.
Identifiers: France, Convex functions, *Spline interpolation.

Computer programs are described for the calculation of four types of spline functions performing minimization of interpolation, smoothing, inequality type constants, and association with convex function, based on previously developed algorithms. The methods used are compared from a numerical point of view. All the methods were written as a FORTRAN subprogram.

N77-28866/0CP PC **A03**/MF **A01**
Aeronautical Research Associates of Princeton, Inc., N. J.
Computer Transformation of Partial Differential Equations into Any Coordinate System.
R. D. Sullivan. Jun 77, 41p Rept nos. NASA-CR-152020, ARAP-309

Contract NAS2-8014

Descriptors: *Computer programs, *Partial differential equations, *Tensor analysis, Coordinates, Equations of motion, Flow distribution, Fortran, Navier-stokes equation.
Identifiers: TENSR computer program, Computer calculations.

The use of tensors to provide a compact way of writing partial differential equations in a form valid in all coordinate systems is discussed. In order to find solutions to the equations with their boundary conditions they must be expressed in terms of the coordinate system under consideration. The process of arriving at these expressions from the tensor formulation was automated by a software system, TENSR. An allied system that analyzes the resulting expressions term by term and drops those that are negligible is also described.

N77-31896/2CP PC **A06**/MF **A01**
Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
Discrimination Between Competitive Models: disc.
M.S. Thesis.
J. F. D. Filho. Jun 77, 111p Rept no. INPE-1027-TPT/051
In Portuguese; English Summary.

Descriptors: *Computer programming, *Computerized simulation, *Mathematical models, Algorithms, Discriminators, Information theory, Bayes theorem, Discrimination, Reaction kinetics, Urban research.
Identifiers: Brazil.

The discrimination among models which compete to represent a given system, using the Box and Hill algorithm, is the main objective of this work. Based on Bayesian statistics and information theory, this algorithm uses a sequential procedure to discriminate the best model, and indicates how to improve the discrimination between the two most competing models. A computer program was implemented, and two applications are presented, dealing with chemical reaction mechanisms and the accessibility function among urban cells, respectively. Concerning urban accessibility, it is found that the gravity function is best suited to Sao Jose dos Campos urban data.

N77-32825/0CP PC **A03**/MF **A01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
Software for C1 Interpolation.
C. L. Lawson. 15 Aug 77, 40p Rept nos. NASA-CR-155047, JPL-PUBL-77-30
Contract NAS7-100
Subm-Submitted for Publication. Conf-Presented at Symp. On Mathematical Software, Madison, Wis., 28-30 Mar. 1977.

Descriptors: *Computer systems programs, *Interpolation, Linear programming, Mathematical models, Algorithms, Least squares method, Numerical analysis, Spline functions, Surface properties.

The problem of mathematically defining a smooth surface, passing through a finite set of given points is studied. Literature relating to the problem is briefly reviewed. An algorithm is described that first constructs a triangular grid in the (x,y) domain, and first partial derivatives at the modal points are estimated. Interpolation in the triangular cells using a method that gives C sup.1 continuity overall is examined. Performance of software implementing the algorithm is discussed. Theoretical results are presented that provide valuable guidance in the development of algorithms for constructing triangular grids.

N78-15729/4CP PC **A03**/MF **A01**
National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
An Automated Procedure for Calculating System Matrices from Perturbation Data Generated by an Eai Pacer and 100 Hybrid Computer System.
E. J. Milner, and S. M. Krosel. Dec 77, 44 Rept nos. NASA-TM-73869, E-9465

Descriptors: *Hybrid computers, *Matrices (Mathematics), Perturbation, Computerized simulation, Finite difference theory, Linear systems.
Identifiers: *Computer calculations.

Techniques are presented for determining the elements of the A, B, C, and D state variable matrices for systems simulated on an EAI Pacer 100 hybrid computer. An automated procedure systematically generates disturbance data necessary to linearize the simulation model and stores these data on a floppy disk. A separate digital program verifies this data, calculates the elements of the system matrices, and prints these matrices appropriately labeled. The partial derivatives forming the elements of the state variable matrices are approximated by finite difference calculations.

N78-19869/4CP PC **A03**/MF **A01**
Douglas Aircraft Co., Inc., Santa Monica, Calif.
A Solution to the Surface Intersection Problem.
Final Report.
H. G. Timer. 29 Nov 77, 50p Rept nos. NASA-CR-152116, MDC-J7789
Contract NAS2-9590

Descriptors: *Descriptive geometry, Boolean functions, Matrices(Mathematics), Cartesian coordinates, Computer programs, Cubes (Mathematics), Data bases, Fortran.
Identifiers: IBM-370 computers.

An application-independent geometric model within a data base framework should support the use of Boolean operators which allow the user to construct a complex model by appropriately combining a series of simple models. The use of these operators leads to the concept of implicitly and explicitly defined surfaces. With an explicitly defined model, the surface area may be computed by simply summing the surface areas of the bounding surfaces. For an implicitly defined model, the surface area computation must deal with active and inactive regions. Because the surface intersection problem involves four unknowns and its solution is a space curve, the parametric coordinates of each surface must be determined as a function of the arc length. Various subproblems involved in the general intersection problem are discussed, and the mathematical basis for their solution is presented along with a program written in FORTRAN IV for implementation on the IBM 370 TSO system.

N78-20876/6CP PC **A03**/MF **A01**
Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany).
Studies in the Frequency Domain Design of Multivariable Systems.
R. Mitra. Sep 77, 39p Rept no. DLR-IB-552-77/24

Descriptors: *Systems engineering, Frequencies, Independent variables, Mathematical models, Systems stability, Computer programs, Helicopters, Matrices (Mathematics), Systems analysis, Vibration isolators.
Identifiers: West Germany.

The theoretical aspects of multivariable systems design were investigated following the Rosenbrock method of diagonal dominance. The multivariable stability was studied and a positive test derived. The application of diagonal dominance and Gershgorin bands for stability analysis are discussed. The overall design procedure is outlined and a practical application to vibration isolation for a helicopter is given.

N78-24821/8CP PC **A03**/MF **A01**
National Research Inst. for Mathematical Sciences, Pretoria (South Africa).
Algorithms for Solving Scalar and Block-Cyclic Tridiagonal Systems of Linear Algebraic Equations.
I. M. Navon. Jul 77, 49p Rept nos. CSIR-SR-WISK-265, ISBN-0-7988-1156-0

Descriptors: *Matrices(Mathematics), Algorithms, Linear equations, Scalars, Boundary value problems, Computer programs, Finite difference theory.
Identifiers: South Africa.

Several algorithms are presented for solving the system Ax = b, where A is a diagonally dominant scaler cyclic tridiagonal matrix. Two of the algorithms are generalized for the block-cyclic tridiagonal case, and conditions for ensuring their numerical stability are discussed. With a view to a finite-difference solution, by the ADI method, of the shallow-water equations over a domain with periodic boundary conditions, two computer programs are presented for solving both scaler and block-cyclic tridiagonal systems.

N78-26778/8CP PC **A03**/MF **A01**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
Basic Linear Algebra Subprograms for Fortran Usage.
C. L. Lawson, R. J. Hanson, D. R. Kincaid, and F. T. Krogh. Oct 77, 41p Rept nos. NASA-CR-156932, SAND-77-0898
Contract EY-76-C-04-0789

Descriptors: *Computer programming, Computer programs, Fortran, Linear equations, Scaling laws, Transformations(Mathematics), Vectors(Mathematics).
Identifiers: *Linear algebra, IBM-360/67 computers, CDC-6600 computers, CDC-7600 computers, UNIVAC-1108 computers.

A package of 38 low level subprograms for many of the basic operations of numerical linear algebra is presented. The package is intended to be used with FORTRAN. The operations in the package are dot products, elementary vector operations, Givens transformations, vector copy and swap, vector norms, vector scaling, and the indices of components of largest magnitude. The subprograms and a test driver are available in portable FORTRAN. Versions of the subprograms are also provided in assembly language for the IBM 360/67, the CDC 6600 and CDC 7600, and the Univac 1108.

N78-28865/1CP PC **A03**/MF **A01**
National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
Description of a Computer Program and Numerical Techniques for Developing Linear Perturbation Models from Nonlinear Systems Simulations.
J. E. Dieudonne. Jul 78, 41p Rept nos. NASA-TM-78710, L-12114

Descriptors: *Computer programs, Nonlinear systems, Perturbation, Differential equations, Jacobi matrix method, Simulation.
Identifiers: Nonlinear differential equations, Perturbation theory, *Terminal controlled vehicles.

A numerical technique was developed which generates linear perturbation models from nonlinear aircraft vehicle simulations. The technique is very general and can be applied to simulations of any system that is described by nonlinear differential equations. The computer program used to generate these models is discussed, with emphasis placed on generation of the Jacobian matrices, calculation of the coefficients needed for solving the perturbation model, and generation of the solution of the linear differential equations. An example application of the technique to a nonlinear model of the NASA terminal configured vehicle is included.

N78-29819/7CP PC **A05**/MF **A01**
Waterloo Univ. (Ontario). Dept. of Mechanical Engineering.
The Finite Element Method Applied to a Class of Time-Dependent Nonlinear Partial Differential Equations.
Z. Mazhar. May 77, 80 Rept no. TN-21

Descriptors: *Finite element method, *Nonlinear differential equations, *Partial differential equations, Time dependence, Algebra, Computer programs, Conductive heat transfer, Fluid flow, Galerkin method, Numerical analysis.
Identifiers: Canada.

The finite element - Galerkin approximation is utilized for the solution of a class of time-dependent partial differential equations. Among the types of partial differential equations considered are unsteady linear/nonlinear heat conduction and also diffusion of a concentration in a fluid flow. A considerable number of problems are solved and compared with the available finite difference and/or variational and/or analytical solutions. Some interesting observations are also discussed parallel to the solution procedure and presentation of results. The highly sparse algebraic systems of equations are solved by means of the Gauss-Seidel iteration method. Based on the available literature and the observations had, the efficiency of the Gauss-Seidel method for this type of problems is also discussed. Triangular idealization and linear elements are used throughout the formulations. A computer program is also presented, in which, with some minor changes, higher order elements can also be utilized.

N78-29843/7CP PC **A04**/MF **A01**
National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
A Statistical Package for Computing Time and Frequency Domain Analysis.
J. Brownlow. Aug 78, 80p Rept nos. NASA-TM-56045, H-981

Descriptors: *Spectrum analysis, *Time series analysis, Digital filters, Fourier analysis, Frequency analyzers, Computer programs, Data processing, Descriptions, Estimates.
Identifiers: SPA computer program.

The spectrum analysis (SPA) program is a general purpose digital computer program designed to aid in data analysis. The program does time and frequency domain statistical analyses as well as some preanalysis data preparation. The capabilities of the SPA program include linear trend removal and/or digital filtering of data, plotting and/or listing of both filtered and unfiltered data, time domain statistical characterization of data, and frequency domain statistical characterization of data.

N78-31835/9CP PC **A16**/MF **A01**
Toronto Univ. (Ontario). Inst. for Aerospace Studies.
Numerical Minimization Methods for Functionals: Comparison and Extensions.
Ph.D. Thesis.
S. C. Garg. Jul 77, 353p Rept nos. UTIAS-209, CN-ISSN-0082-5255
Subm-Sponsored by Natl. Res. Council of Can.

Descriptors: *Numerical analysis, Function space, Functionals, Optimization, Computer programs, Conjugates, Differential equations, Functional analysis, Gradients, Steepest descent method.
Identifiers: Control theory, Numerical integration, Quasilinearization, Conjugate gradient method, Canada, Theses.

A unification and review of numerical minimization methods for functionals on finite and infinite-dimension spaces is presented, as well as a generalization of the symmetric rank-one and Davidon's second algorithms and their properties to infinite-dimensional space. A computational comparison and evaluation of selected methods, including a second-order method, is included. Numerical methods are given for optimal control problems having functionals depending on fixed parameters and functions of time. Methods examined include: steepest descent, optimum gradient, conjugate gradient, Davidon's variable-metric method, modified quasilinearization with optimum initial choice of multipliers, and two versions of Davidon's rank-one method, extended by the author to the present class of problems. A new second-order gradient method is derived from a functional analysis viewpoint, and a mathematical justification is given for the so-called 'clipping' technique of treating control variable inequality constraints in gradient-based methods. The implementation of these algorithms as computer programs is analyzed with particular attention to the integration of ordinary differential equations.

N78-31845/8CP PC **A04**/MF **A01**
Royal Aircraft Establishment, Farnborough (England).
The Development of Quasi-Newton Methods for Unconstrained Minimisation.
A. G. Purcell. Aug 77, 68p Rept nos. RAE-TR-77132, BR60413

Descriptors: Algorithms, Constraints, Newton-Raphson method, Optimization, Computer programming, Finite difference theory, Fortran, Iteration, Nonlinear programming, User manuals(Computer programs).
Identifiers: *Unconstrained minimization, Matrices(Mathematics), Great Britain.

Formulae for updating matrices in connexion with the quasi-Newton iteration are derived so as to emphasize the principles involved. Computational aspects are discussed and two FORTRAN (CM 0402 and M2 1UNC) programs for nonlinear minimization, subject to bounds on the variables, are described and their use of finite difference derivatives, treatment of bounds, line searches, and post-optimal sensitivity facilities are compared to demonstrate the manner in which the subject has progressed in recent years. Brief user guides to the two programs are contained in appendices.

N79-11804/8CP PC **A03**/MF **A01**
National Aeronautics and Space Administration, Washington, DC.
Numerical Method for Solution of Systems of Non-Stationary Spatially One-Dimensional Nonlinear Differential Equations.
S. K. Morozov, and O. P. Krasitskiy. Nov 78, 35p Rept nos. NASA-TM-75557, PR-396
Contract NASW-3198

Descriptors: Differential equations, Nonlinear equations, Numerical analysis, Computer programs, Descriptions, Fortran, Partial differential equations.
Identifiers: *Nonlinear differential equations, *Numerical integration, BESM-6 computers, YeS computers, Newton method.

A computational scheme and a standard program is proposed for solving systems of nonstationary spatially one-dimensional nonlinear differential equations using Newton's method. The proposed scheme is universal in its applicability and its reduces to a minimum the work of programming. The program is written in the FORTRAN language and can be used without change on electronic computers of type YeS and BESM-6. The standard program described permits the identification of nonstationary (or stationary) solutions to systems of spatially one-dimensional nonlinear (or linear) partial differential equations. The proposed method may be used to solve a series of geophysical problems which take chemical reactions, diffusion, and heat conductivity into account, to evaluate nonstationary thermal fields in two-dimensional structures when in one of the geometrical directions it can take a small number of discrete levels, and to solve problems in nonstationary gas dynamics.

ORNL/CSD/TM-12 PC **A03**/MF **A01**
Oak Ridge National Lab., Tenn.
IUCALC: A FORTRAN Subroutine for Calculating Polygon-Line Intersections, and Polygon--Polygon Intersections, Unions, and Relative Differences
R. G. Edwards, and P. R. Coleman. Aug 76, 35p
Contract W-7405-eng-26

Descriptors: *Computer codes, *Maps, Fortran, Geometry, I codes, Ibm computers.
Identifiers: ERDA/990200, IBM-360 computers, IUCALC computer program.

The IBM 360 FORTRAN Subroutine IUCALC may be used to calculate polygon--chain (of line segments) intersections and polygon--polygon intersections, unions, and relative differences. The subroutine is used in computer-assisted geographical analysis involving areal quantities defined in terms of polygons. The subroutine is also used in producing choropleth (shaded) displays of polygon or gridded data. 3 figures. (ERA citation 02:004347)

ORNL/CSD/TM-39 PC **A02**/MF **A01**
Oak Ridge National Lab., Tenn.
Comparison of a Band Matrix Method with a Block Tridiagonal Matrix Method
S. J. Lynch, and H. R. Hicks. Sep 77, 21p
Contract W-7405-ENG-26

Descriptors: *Computer codes, *Matrices, B codes, Calculation methods, CDC computers, Comparative evaluations, Fortran, Numerical solution, T codes.
Identifiers: ERDA/990200, Tridiagonal matrices.

The matrix equation Av + d = 0, where A is a block tridiagonal matrix, is solved by two methods: a band matrix solver and a block tridiagonal technique. The computation speed of the two methods is comparable. The method which is actually faster will depend on the details of the optimization of each method. 1 table. (ERA citation 03:009501)

ORNL/CSD-2 PC **A04**/MF **A01**
Oak Ridge National Lab., Tenn.
Explicit Inverses of Some Special Matrices (With a Few Computer Programs).
V. R. R. Uppuluri, and B. L. Kirk. Feb 76, 59p
Contract W-7405-eng-26

Descriptors: *Matrices, Algorithms, Computer codes.
Identifiers: ERDA/990200, *Inverse problems.

Explicit inverses of some classes of special matrices are presented. In Section I, the tridiagonal matrices are discussed. In Section II a discussion is given of an algorithm due to Sherman and Morrison, which is useful in finding the inverse, when an explicit inverse is known for an unperturbed matrix. Section III presents inverses of some patterned matrices. Appendix A and Appendix B contain computer programs of some of the problems discussed in Sections I, II, and III. (ERA citation 01:015364)

ORNL/CSD-21 PC **A02**/MF **A01**
Oak Ridge National Lab., Tenn.
ALPS: Matrices with Nonpositive off-Diagonal Entries
A. Berman, R. S. Varga, and R. C. Ward. Mar 77, 21p
Contract W-7405-ENG-26

Descriptors: *Matrices, Stability.
Identifiers: ERDA/990200, ALPS computer program.

This paper characterizes and interrelates various degrees of stability and semipositivity for real square matrices having nonpositive off-diagonal entries. The major classes considered are the sets of diagonally stable, stable, and semipositive matrices, denoted respectively by a, L, and S. The conditions defining these classes are weakened, and the resulting classes are examined. Their relationship to the classes of real matrices P and P sub 0 , whose off-diagonal entries are nonpositive and whose principal minors are, respectively, all positive and all nonnegative, is also included. (ERA citation 02:040310)

ORNL/CSD-9 PC **A03**/MF **A01**
Oak Ridge National Lab., Tenn.
Eigensystem Computation for Skew-Symmetric Matrices and a Class of Symmetric Matrices
R. C. Ward, and L. J. Gray. May 76, 32p
Contract W-7405-eng-26

Descriptors: *Computer codes, *Matrices, Nuclear models, Algorithms, Computer calculations, Eigenvalues, Eigenvectors, Fortran, I codes, Ibm computers, T codes.
Identifiers: ERDA/990200, ERDA/653007.

An algorithm is given for computing the eigenvalues and (optionally) the eigenvectors of either a skew-symmetric matrix or a symmetric tridiagonal matrix with constant diagonal. The algorithm uses only orthogonal similarity transformations, and is believed to be the most efficient algorithm available for computing all the eigenvalues or the complete eigensystem. 2 tables. (ERA citation 01:022352)

ORNL-IBP-70-1 HC A03 MF **A01**
Oak Ridge National Lab., Tenn.
Testing the Uniformity of Variance in Arithmetic and Logarithmic Units of a Y-Variable for Classes of an X-Variable.
G. L. Baskerville. Apr 70, 38p
Contract W-7405-eng-26

Descriptors: *Regression analysis, Curve fitting, *Analysis of variance, Computer programs, Correlation techniques.

For abstract, see NSA 2412

ORNL-NSF-EP-13 PC **A03**/MF **A01**
Oak Ridge National Lab., Tenn.
Simple- Multivariate Linear Regression Analysis
G. W. Westley. Jan 72, 43p
Contract W-7405-ENG-26

Descriptors: *Computer programs.

For abstract, see NSA 26 10, number 25082.

ORNL-TM-4258 PC **A02**/MF **A01**
Oak Ridge National Lab., Tenn.
Program to Evaluate the Second Form of the Confluent Hypergeometric Function
N. M. Larson, and I. J. Lucas. Jul 73, 20p
Contract W-7405-eng-26

Descriptors: *Hypergeometric functions, *Computer codes, Differential equations, K codes, K codes, Numerical solution.
Identifiers: AEC.

For abstract, see NSA 28 06, number 15053.

ORNL-TM-4385 PC **A02**/MF **A01**
Oak Ridge National Lab., Tenn. (Usa).
Program to Evaluate Associated Legendre Polynomials and Spherical Harmonics
N. M. Larson. Dec 73, 21p
Contract W-7405-eng-26

Descriptors: *Legendre polynomials, *Computer codes, *Spherical harmonics, Computer codes, Fortran.
Identifiers: AEC.

For abstract, see NSA 29 04, number 09699.

ORNL-TM-4404 PC **A03**/MF **A01**
Oak Ridge National Lab., Tenn. (Usa).
User'S Manual for Modsov, a Terminal Operated Program Solving the Linear Matrix Equation $X = AX + K$
F. H. Clark, R. S. Booth, and H. A. Vanderploeg. Jan 74, 41p
Contract W-7405-eng-26

Descriptors: *Differential equations, *Analytical solution, *Computer codes, *M codes, *Ecology, *Mathematical models.
Identifiers: AEC.

For abstract, see NSA 29 07, number 17953.

ORNL-TM-4588 PC **A02**/MF **A01**
Oak Ridge National Lab., Tenn.
Subroutine Cauchy: Complex Roots of a Function Using a Cauchy Integral Technique.
C. O. Jr. Beasley, and H. K. Meier. Aug 74, 24p
Contract W-7405-eng-26

Descriptors: *Computer codes, *C codes, Geometry, Mathematics, Numerical solution, Programming.

For abstract, see NSA 30 11, number 31344.

ORNL/TM-5950 PC **A02**/MF **A01**
Oak Ridge National Lab., Tenn.
Contouring on Isoparametric Surfaces
J. E. Akin, and W. H. Gray. Oct 77, 14p
Contract W-7405-ENG-26

Descriptors: *Computer codes, *Interpolation, CDC computers, Computer calculations, IBM computers, L codes, Nonlinear problems, Three-dimensional calculations, Two-dimensional calculations.
Identifiers: ERDA/990200.

A general nonlinear interpolation procedure, which uses standard isoparametric interpolation functions, is presented for contouring on any isoparametric surface. (ERA citation 03:009502)

ORNL-4604 PC **A02** MF **A01**
Oak Ridge National Lab., Tenn.
Computer Program for the Inversion of the Laplace Transform.
F. W. Stallmann, and Sandra H. Merriman. Sep 70, 18p
Contract W-7405-ENG-26

Descriptors: *Computer programs.

For abstract, see NSA 24 23, number 50287.

ORNL-4661 PC **A09** MF **A01**
Oak Ridge National Lab., Tenn.
Mathematics Division Annual Progress Report for Period Ending December 31, 1970
Apr 71, 191p
Contract W-7405-ENG-26

Descriptors: *Computer programs, *Computers, *Mathematics, *Statistics.

For abstract, see NSA 26 03, number 05682.

ORNL-4876 PC **E01**/MF **A01**
Oak Ridge National Lab., Tenn.
Percentage Points of Moment Estimators Which Are Ratios with an Application to the Shape Parameter of the gamma Distribution
W. E. Dusenberry, and K. O. Bowman. May 73, 205
Contract W-7405-eng-26

Descriptors: Computer codes, Distribution, Functions, Mathematics.
Identifiers: AEC.

For abstract, see NSA 28 04, number 10504.

PB-191 282/CP HC A03 MF **A01**
Hawaii Inst. of Geophysics, Honolulu.
An Integral Equation Approach to Diffusion Problems.
Richard Paul Shaw. Jan 70, 35p Rept no. HIG-70-1

Descriptors: *Conduction(Heat transfer), Boundary value problems, *Integral equations, Numerical analysis, Surface temperatures, Computer programs, Transients, Nonlinear systems, Green's function, Integration, Diffusion.
Identifiers: Numerical integration.

A method of solution of transient diffusion problems in homogeneous and isotropic media with internal sources and arbitrary (including nonlinear) boundary conditions and initial conditions is proposed. Heat conduction is taken as the physical basis of the problem although the approach is applicable to any other physical diffusion process. The method is based on the reduction of the problem to one only involving surface values of temperature and/or heat flux in the form of an integral equation through the introduction of fundamental solutions and the use of Green's Theorem. The integral equation is solved numerically for two specific examples. (Author)

PB-193 991/CP HC A02 MF **A01**
Atomic Energy of Canada Ltd., Chalk River (Ontario).
Bestfit: An Apex Program to Generate Rational Chebyshev Approximations.
P. Y. Wong. Jul 70, 24p Rept no. AECL-3518

Descriptors: *Functions, Curve fitting, *Approximation(Mathematics), Computer programs, Polynomials, Canada.
Identifiers: BESTFIT computer program, Remes algorithms, Rational functions, Chebyshev approximations.

Based on the Remes Algorithms, rational functions are generated which can be used to fit a given function to a desired accuracy. (Author)

PB-194 701/CP HC A03 MF **A01**
California Univ., Berkeley. Operations Research Center.
Improved Algorithms for Knapsack Problems.
Research rept.
Stuart E. Dreyfus, and Kirk L. Prather. Aug 70, 33p Rept no. ORC-70-30
Grant NSF-GP-15473
Prepared in cooperation with Theodore Barry and Associates, Los Angeles, Calif.

Descriptors: *Mathematical programming, Algorithms, *Cargo, Scheduling, Constraints, Dynamic programming, FORTRAN, Computer programs, Optimization.
Identifiers: Knapsack problem, Integer programming.

Efficient new computational algorithms for solving knapsack problems are presented. They are based on the development of a list of undominated solutions. Problems involving several constraints, as well as the traditional single constraint problem, are treated. (Author)

PB-195 376/CP PC **A05** MF **A01**
Ohio State Univ., Columbus. Computer and Information Science Research Center.
Stability Analysis of Term Similarities for Information Classification Theory.
Technical rept.
Betty A. Mathis, Lee J. White, and David M. Jackson. Jul 70, 83p Rept no. CISRC-TR-70-4
Grant NSF-GN-534.1

Descriptors: *Population(Statistics), Classifications, *Information retrieval, Clumps, Pattern recognition, Correlation techniques, Computer programs, Combinatorial analysis.
Identifiers: Cluster analysis, Similarity theory.

Cluster analysis is intended to reduce detailed information about the individuals of a population to a few generalizations about certain subsets of the population. Many clustering algorithms have been devised which often lead to different classifications even when applied to the same population and the same set of data. However, if a classification is to represent the similarities which exist between subsets of the population, then classifications devised by different algorithms should be in substantial agreement with one another. In order to classify a population, the individuals to be classified must be described by observations made upon them based on a set of qualitative or quantitative attributes. A quantitative attribute is capable of taking on all values in the range of normalization of that attribute and may, therefore, be treated as a continuous variable. A qualitative attribute may assume only a certain number of predetermined states and must, therefore, be treated as a discrete variable. This paper deals with qualitative variables that can be expressed as binary attributes. (Author)

PB-197 154/CP HC A04 MF **A01**
Stanford Univ., Calif. Dept. of Computer Science.
Mpi-Mathematical Programming Language. Specification Manual for Committee Review.
Stanley Eisentat, Thomas Magnanti, Steve Maier, Michael McGrath, and Vincent Nicholson. Nov 70, 66p Rept no. STAN-CS-70-187
Grant NSF-GJ-320

Descriptors: *Mathematical programming, *Programming language, Algorithms, Computer programming, Management planning, Data processing, Programming manuals.
Identifiers: MPL programming language.

Mathematical Programming Language (MPL) is intended as a highly readable, user oriented, programming tool for use in the writing and testing of mathematical algorithms, in particular experimen-

tal algorithms for solving large-scale linear programs. It combines the simplicity of standard mathematical notation with the power of complex data structures. Variables may be implicitly introduced into a program by their use in the statement in which they first appear. No formal defining statement is necessary. Statements of the 'let' and 'where' type are part of the language. Included within the allowable data structures of MPL are matrices, partitioned matrices, and multidimensional arrays. Ordered sets are included as vectors with their constructs closely paralleling those found in set theory. Allocation of storage is dynamic, thereby eliminating the need for a data manipulating subset of the language, as is characteristic of most high level scientific programming languages. The report summarizes the progress that has been made to date in developing MPL. (Author)

PB-198 416/CP PC **A03** MF **A01**
Stanford Univ., Calif. Dept. of Computer Sciences.
ALGOL 60 Procedures for the Calculation of Interpolating Natural Spline Functions
John G. Herriot, and Christian H. Reinsch. Feb 71, 33p Rept no. STAN-CS-71-200

Descriptors: *Computer programs, Manuals, *Approximation, Functions(Mathematics), *Interpolation, Functions(Mathematics), ALGOL, Measure and integration, Numerical analysis.
Identifiers: ALGOL 60 programming language, *Spline functions, Spline interpolation.

Three ALGOL 60 procedures are described for finding interpolating natural splines of odd degree. The first procedure finds the interpolating natural spline of degree (2m-1) for an arbitrary set of knots. The second procedure specializes the procedure to the case of equidistant knots. The third procedure finds the interpolating cubic spline for an arbitrary set of knots. It should be noted that the cubic case is of widespread use and that the procedure given here for this case is very fast involving much less computational effort than the first two more general procedures. (Author)

PB-199 271/CP PC **A14** MF **A01**
Raytheon Co., Sudbury, Mass. Equipment Div.
Merging Control System. Volume I. Pacer System Analysis and Design
Final rept.
Oct 70, 311p* Rept no. ER70-4200-Vol-1
Contract FR-11-6624
See also Volume 2, PB-199 272.

Descriptors: *Feedback control, Systems engineering, *Vehicular traffic control, Transportation models, *Freeways, *Interchanges, Traffic engineering, Control equipment, Detectors, Sensor characteristics, Computerized simulation, Control simulation, Display devices, Computer systems hardware, Computer systems program's, Design criteria.
Identifiers: Gap prediction, *Pacer system, *Merging control systems.

Volume 1 of the Merging Control System Final Report described the design of a closed loop Merging Control System and includes the system analyses and investigations which influenced system configurations and hardware designs. Section 1 of this volume comments briefly on existing merging control systems, defines the system objectives, describes the system functionally, and provides background on selection of a test site. Section 2 describes the system configuration and related hardware and software requirements and summarizes the several operating states of the system. Section 3 provides the system analyses which contributed to the formulation of system concepts and influenced overall system configurations. The analyses are especially oriented towards considerations for public safety. Section 4 treats in detail the design of the Pacer System hardware and includes studies directly related to hardware design. Section 5 describes initial plans for a system simulation program which was not implemented because of funding constraints. (BPR abstract)

PB-199 272/CP PC **A18** MF **A01**
Raytheon Co., Sudbury, Mass. Equipment Div.
Merging Control System. Volume II. Pacer System Software
Final rept.
Dec 70, 403p Rept no. ER70-4200-Vol-2
Contract FH-11-6624
See also Volume 1, PB-199 271 and Volume 3, PB-199 273.

Descriptors: *Feedback control, *Computer systems programs, *Vehicular traffic control, Transportation models, *Freeways, *Interchanges, Traffic engineering, Control equipment, Input output routines, Control simulation, Simulator routines, Flow charts, Interfaces, Quality assurance.
Identifiers: *Pacer system, *Merging control systems.

Volume 2 of the Merging Control System Final Report contains a narrative description and series of flow charts for the 'pacer system' operational program. (BPR abstract)

PB-199 273/CP PC **A13** MF **A01**
Raytheon Co., Sudbury, Mass. Equipment Div.
Merging Control System. Volume III. Pacer System Program Listing
Final rept.
Dec 70, 300p* Rept no. ER70-4200-Vol-3
Contract FH-11-6624
See also Volume 2, PB-199 272 and Volume 4, PB-199 274.

Descriptors: *Feedback control, *Computer programs, *Vehicular traffic control, Transportation models, *Freeways, *Interchanges, Traffic engineering, Control equipment, Input output routines, Subroutines, Computer logic, Control sequences, Computer systems programs.
Identifiers: *Pacer system, *Merging control systems.

This volume of the Merging Control final report contains the complete assembly listing for the Pacer System operational program. A narrative description and complete series of flow charts for this program is contained in Volume 2 of this report. Included, herein, are all of the subprograms, subroutines and engineering modifications of the operational program as well as the test and utility programs that were developed for the system. (BPR abstract)

PB-199 274/CP PC **A99** MF **A01**
Raytheon Co., Sudbury, Mass. Equipment Div.
Merging Control System. Volume IV. Pacer System Performance Data
Final rept.
Oct 70, 727p* Rept no. ER70-4200-Vol-4
Contract FH-11-6624
See also Volume 3, PB-199 273 and Volume 5, PB-199 275.

Descriptors: *Computer programs, *Printouts, *Vehicular traffic control, Transportation models, *Freeways, Interchanges, Traffic engineering, Control equipment, Computer systems programs, Feedback control, Traffic surveys, Counting.
Identifiers: *Pacer system, *Merging control systems.

Volume 4 of the Merging Control System Final Report contains the system operational data that was collected during the operation of the 'pacer' system. It also includes the data that was collected prior to the operation of the 'pacer' system. This 'no system' data was used for comparative purposes. The analysis of the data presented in this volume is contained in Volume 5. (BPR abstract)

PB-199 279/CP PC **A15** MF **A01**
Raytheon Co., Sudbury, Mass. Equipment Div.
Merging Control System. Volume IX. Green Band Performance Data
Final rept.
Oct 70, 331p* Rept no. ER70-4200-Vol-9
Contract FH-11-6624
See also Volume 8, PB-199 278 and Volume 10, PB-199 280.

Descriptors: *Computer programs, *Printouts, *Vehicular traffic control, *Transportation models, *Freeways, *Interchanges, Traffic engineering, Adaptive systems, Traffic surveys, Counting, Time measurement, Acoustic measurement, Velocity measurement.
Identifiers: *Green Band system, *Merging control systems, Open loop control systems.

Volume 9 of the Merging Control System Final Report contains the performance data that was collected during the operation of the 'green band' system. (BPR abstract)

PB-200 281/CP PC **A03** MF **A01**
Illinois Univ., Urbana. Dept. of Computer Science.
Parallel Methods and Bounds of Evaluating Polynomials
Kiyoshi Maruyama. Mar 71, 48p Rept no. 437
Grant NSF-GJ-328

Descriptors: *Polynomials, Computation, *Computer programming, Polynomials, Computer programs, Algorithms, Theorems.

A lower bound of the maximum evaluable degree of a polynomial for each step s is given, and is N'(s) $>$ 2 to the power (s(1 - delta)), delta approximately = the square root of (2/s). An upper bound is derived for the number of steps required to evaluate polynomials of degree n, and is given by T (P sub n) $<$ (1 + epsilon) (log of n to the base 2), which approaches theoretical lower bound (log of (2n + 1) to the base 2) as n approaches infinity, where epsilon is approximately equal to the square root of (2/(log of n to the base 2)). An upper bound of the number of operation required to achieve the theoretical lower bound of steps required to evaluate polynomials of degree n is given as Cn, C $>$ 2. Furthermore a systematic construction of computation trees, multi-folding and modified multi-folding methods, which achieves the bound is given. The dual problem approach shows the existance of a simple scheduling algorithm to evaluate polynomials within the bound. (Author)

PB-202 937/CP PC **A08** MF **A01**
Texas Water Development Board, Austin.
Stochastic Optimization and Simulation Techniques for Management of Regional Water Resource Systems. Volume I. Introduction
Completion rept.
Jul 71, 163p 131, OWRR-C-1681(3156) (1)-Vol-1
Grant DI-14-31-0001-3156
See also Volume 2A thru Volume 2F, PB-202 938.

Descriptors: *Water resources, Management planning, *Linear programming, Stochastic processes, Mathematical models, Reservoirs, Water supply, Runoff, Computer programs, Data processing, Cost analysis, Optimization, Texas.

The report defines a methodology for finding an optimal (most reasonable) staging plan for implementing a multibasin water resource system--a system that must meet, with an optimal level of shortages, prespecified but highly variable demands for water that increase over time--a system such as the proposed Texas Water System. The methodology explicitly evaluates the impact that stochastic variability of the meteorologic variables and uncertainty in the remaining variables have on determining which of an over-specified set of reservoirs and pump-canals should be constructed, how large each of the reservoirs and pump-canals should be at various points on the demand build-up curve, and how the resulting optimized system should be operated both during and after the period in which facilities are being added or increased in size, to minimize the present worth of their construction costs, expected operation costs, and expected penalty costs incurred for demands not met. The methodology is designed to analyze a problem on a monthly basis using historical or stochastic hydrologic input data sequences, a specified demand build-up period, and an economic life as identified by the user. (Author)

PB-203 499/CP PC **A05** MF **A01**
TRW Systems Group, McLean, Va. Washington Operations.

Synchronous Longitudinal Guidance (SLG) Allocation Algorithm Effectiveness Study
Final rept.
Irene F. Kan, Michael P. Lukas, Lester K. Arquette, and Richard K. Boyd. Jun 71, 76p
06818-W033-R0-00, FRA-RT-72-20
Contract DOT-C-353-66

Descriptors: *Transportation models, Algorithms, *Linear programming, Optimization, Network flows, Transportation management, Computerized simulation, Computer programs, Constraints.
Identifiers: ALTRTG computer program.

A previously developed algorithm for allocating guideway space in a deterministic automated transportation network has already been verified as being a useful traffic management technique. This report investigates the algorithm's effectiveness under a variety of network operating policies and demand conditions. The report develops a methodology for the evaluation of algorithm effectiveness, evaluates the algorithm's effectiveness in representative transportation networks, and identifies unusual network traffic conditions which may degrade effectiveness. Algorithm operation, as determined by computer simulation, is defined to be effective if it produces traffic patterns which match those obtained using linear programming optimization techniques. It was concluded that the algorithm is a useful, flexible and effective tool in controlling traffic patterns in a deterministic transportation system. (Author)

PB-203 568/CP PC **A06** MF **A01**
Geological Survey, Washington, D.C.
Nonconstant Variance Regression Analysis Program
Marshall Strong Hellmann. 1970, 110p Rept nos.
USGS-Computer Contrib-3, USGS-CCD-70-001

Descriptors: *Regression analysis, *Computer programs, Analysis of variance, Statistical tests, Statistical distributions, Confidence limits, FORTRAN, Random variables, Iteration.
Identifiers: Maximum likelihood estimation, FORTRAN 4 programming language.

The program computes the estimates of various statistics using an iterative estimating technique described in the pamphlet 'Non-Constant Variance Regression Analysis' by Hellmann, (1967). The estimates of the regression coefficients obtained by this iterative technique are usually the maximum likelihood estimates of the coefficients. The program is capable of performing a wide variety of regression techniques with a minimal amount of user involvement in the programming requirements. The program has several options, which allow the user a great deal of flexibility in preparing and processing the input data. Provision is made for the user to provide titles for the variables and names for the observations. The results are printed in detail and described in this paper. Confidence intervals are presented along with a histogram of the results and a scatter diagram relating the observed and estimated values of the dependent variable. The coefficients are tested to insure that the solution is a relative maximum. (Author)

PB-203 579/CP PC **A05** MF **A01**
Geologiccal Survey, Denver, Colo.
Application of Bicubic Spline Functions to Two-Dimensional Gridded Data
Walter L. Anderson. Oct 71, 88p Rept no. USGS-GD-71-022

Descriptors: *Interpolation, Cubic equations, *Computer programming, Interpolation, Computer programs, FORTRAN, Grids(Coordinates), Approximation, Mapping.
Identifiers: *Spline functions, FORTRAN 4 programming language, *Spline interpolation, Cubic spline technique.

Generalized FORTRAN IV computer programs using cubic and bicubic spline functions are applied to two-dimensional interpolation problems involving uniformly spaced data grids. These algorithms provide for grids up to 1000 by 1000 points which may contain irregularly defined subregions. Classes of applications are automatic contouring, digital filter weight determinations, automatic cross-contour profiles, second vertical derivative maps, and directional derivative gradient maps. (Author)

PB-204 590/CP PC **A12**/MF **A01**
Wisconsin Univ., Madison. Dept. of Computer Sciences.
The Exact Solution of Systems of Linear Equations With Polynomial Coefficients
Technical rept.
Michael T. McClellan. Sep 71, 266p Rept nos. TR-136, WIS-CS-71-136
Grant NSF-GJ-239, NGL-21-002-008
Doctoral thesis.

Descriptors: *Matrices(Mathematics), Numerical analysis, *Computer programming, Applications of mathematics, Algorithms, Polynomials, Linear transformations, Computer programs, List processing languages, FORTRAN, Theses.
Identifiers: FORTRAN 4 programming language.

Modular algorithms for linear equations solution, matrix inversion, determinant calculation, null space basis generation, and matrix multiplication are developed, all for matrices with polynomial entries. Theoretical computing times are obtained for all algorithms. The algorithms are programmed in Fortran IV, forming a module of the SAC-1 system for symbolic and algebraic calculation, and empirical computing times are given for representative cases. (Author)

PB-205 818/CP PC **A02**/MF **A01**
Commonwealth Scientific and Industrial Research Organization, St. Lucia (Australia). Div. of Soils.
A Computer Program for Fitting Non-Linear Regression Models to Data by Least Squares
P. J. Ross. 1971, 25p Rept no. Technical Paper-6

Descriptors: *Regression analysis, *Computer programs, Least squares method, Curve fitting, Digital computers, Soil chemistry, Soil physics, Partial differential equations, Control sequences, FORTRAN, Australia.
Identifiers: FORTRAN 4 programming language.

The statistical theory for fitting models non-linear in the parameters to be estimated is being developed. Techniques of mechanistic model-building which use this theory may prove useful in soil research. The report describes a computer program for fitting such non-linear models to data by least squares. The program has been written as a subroutine with execution under the control of the user by means of control statements. In this way, it is possible to use the program for solving a variety of problems. Estimates of the unknown parameters and a confidence region for them are calculated, together with measures of non-linearity which indicate whether the statistical theory of linear models is applicable. The statistical and computational bases of the program are discussed in some detail. A description of the calling sequence and control statements is given, and three illustrative programs using the subroutine are presented. Results from these are included as typical examples of what the user can expect. (Author)

PB-206 624/CP PC-**GPO**/MF **A01**-NTIS
Bureau of Mines, Washington, D.C.
Computer Simulation of Particulate Systems
Lindsay D. Norman. 1971, 61p Rept no. BM-B-658
Paper copy available from GPO $0.60 as stock no. 2404-0946, 128.3:658.

Descriptors: *Packaging, Computerized simulation, *Particles, Combinatorial analysis, Analytic geometry, Mathematical models, Particulate composites, Statistical analysis, Spheres.
Identifiers: Computer graphics, Particulate packing, Random packing.

Computer models for simulating the construction and for calculating the properties of particulate solids in random two- and three-dimensional systems, coverings, and packings, respectively, were developed for many different distributions of sizes. The statistical geometry of loose random coverings and packings was studied and several new interpretations of the area-covering or space-filling requirements in these systems were made. A unique method for predicting the geometrical properties of loose random packings was developed that did not require the simulation of the assembled packing. Instead, the simplical tetrahedra in any packing were predictable and were used to predict most of the properties of that packing. A review of the packing literature is included.

PB-207 268/CP PC **A14**/MF **A01**
Peat, Marwick, Mitchell and Co., Washington, D.C.
Network Flow Simulation for Urban Traffic Control System
Technical rept. (Final), 17 Mar 70-14 Jun 71
Jeffrey M. Bruggeman, Edward Lieberman, and R. D. Worrall. Jun 71, 302p FH-11-7462-2
Contract FH-11-7462
Prepared in cooperation with General Applied Science Lab., Westbury, N.Y. See also Appendix 1, PB-207 269.

Descriptors: *Transportation models, *Network flows, *Vehicular traffic control, Urban areas, Computer programming, Computerized simulation, FORTRAN, Stochastic processes, Queueing theory, Transportation management, Statistical analysis, Subroutines, Mathematical models, District of Columbia.
Identifiers: FORTRAN 4 programming language.

The report describes the development, calibration and validation of the network simulation model UTCS-1, designed to serve as a mechanism for evaluating alternative traffic network control strategies. The UTCS-1 model is programmed in FORTRAN IV and incorporates the following major features: (a) Stochastic simulation of individual vehicles by type, using a simplified car-following model with time-scanning periods of one second; (b) capability of representing a network of, at least, 100 nodes; (c) a complete set of measures of effectiveness of the traffic system in the output, (d) detailed treatment of pedestrian/vehicle interaction, bus traffic and intra-link friction such as illegal parking and taxicab stoppages; (e) simulation of electronic surveillance systems; and (f) replication of all forms of traffic controls including real-time dynamic signal control systems. (Author)

PB-207 269/CP PC **A07**/MF **A01**
Peat, Marwick, Mitchell and Co., Washington, D.C.
Network Flow Simulation for Urban Traffic Control System. Appendix I. Program Manual
Final rept. 17 Mar 70-14 Jun 71
Jeffrey M. Bruggeman, Edward Lieberman, and R. D. Worrall. Jun 71, 148p FH-11-7462-2-App-1
Contract FH-11-7462
Prepared in cooperation with General Applied Science Lab., Westbury, N.Y. See also PB-207 268 and Appendix 2, PB-207 270.

Descriptors: *Transportation models, *Network flows, *Programming manuals, Vehicular traffic control, Computer programs, Computerized simulation, FORTRAN, Mathematical models.
Identifiers: FORTRAN 4 programming language.

The report is divided into three major parts. The first and third parts are designed primarily for use by both the computer specialist and the traffic researcher. The second part is addressed primarily to the computer specialist. Part 2 contains detailed operating instructions for the traffic network simulation model and a comprehensive listing of error messages. (Author)

PB-207 270/CP PC **A12**/MF **A01**
Peat, Marwick, Mitchell and Co., Washington, D.C.
Network Flow Simulation for Urban Traffic Control System. Appendix II. Subroutine Documentation and Storage Arrays
Final rept. 17 Mar 70-14 Jun 71
Jeffrey M. Bruggeman, Edward Lieberman, and R. D. Worrall. Jun 71, 262p FH-11-7462-App-2
Contract FH-11-7462
Prepared in cooperation with General Applied Science Lab., Westbury, N.Y. See also Appendix 1, PB-207 269.

Descriptors: *Transportation models, *Network flows, *Vehicular traffic control, Urban areas, Sub-

routines, Data storage, Transportation management, Stochastic processes, Queueing theory, Programming manuals, Data processing, Computerized simulation, Mathematical models, FORTRAN.
Identifiers: FORTRAN 4 programming language.

The paper contains detailed documentation of each of the 43 subroutines making up the UTCS-1 traffic network simulation model developed in this study. Flow charts outline the logic of each subroutine and all storage arrays are described. (Author)

PB-209 195/CP PC **A05**/MF **A01**
Wisconsin Univ., Madison. Dept. of Computer Sciences.
The SAC-1 Polynomial GCD and Resultant System
Technical rept.
George E. Collins. Feb 72, 98p Rept no. WIS-CS-145-72
Grant NSF-GJ-239
Also pub. as Madison Academic Computing Center, Wis. Technical rept. no. 27.

Descriptors: *Computer programming, Algorithms, *Polynomials, Algebraic number theory, FORTRAN, Chinese remainder theorem, Computer programs, Random variables, Mathematical logic.
Identifiers: Computational complexity.

The report is the eighth in the series of SAC-1 subsystems for Symbolic and Algebraic Calculation. The present subsystem provides programs for computing the greatest common divisors and resultants of multivariate polynomials, which are based on the new and much faster modular algorithms of W. S. Brown and G. E. Collins. The system also contains modular-algorithm programs for polynomial multiplication and trial division, and improved programs for the Chinese remainder theorem and interpolation. The report contains, for each program in the system, a user's functional specification, a formal algorithm description, a theoretical computing time, and a FORTRAN program listing. Illustrative empirical computing times are given for many of the programs, and a test program is included for assistance in implementation and use of the system. (Author)

PB-209 629/CP PC **A03**/MF **A01**
Stanford Univ., Calif. Dept. of Computer Science.
Mathematical Programming Language. An Appraisal Based on Practical Experiments
Technical rept.
Pierre E. Bonzon. Feb 72, 27p Rept nos. STAN-CS-72-267, TR-72-6
Grant NSF-GJ-30408X

Descriptors: *Linear programming, *Programming languages, Compilers, Partitions(Mathematics), Simplex method, Iteration, Computer programs, Constraints.
Identifiers: Mathematical programming language.

The newly proposed Mathematical Programming Language is approached from the user's point of view. To demonstrate its facility of use, three programs are presented which solve large scale linear programming problems with the generalized upper-bounding structure. (Author)

PB-209 883/CP PC **A06**/MF **A01**
Wisconsin Univ., Madison. Dept. of Computer Sciences.
The SAC-1 Polynomial Linear Algebra System
Technical rept.
G. E. Colins, and M. T. McClellan. Apr 72, 113p Rept no. WIS-CS-154-72
Grant NSF-GJ-239

Descriptors: *Computer programming, Computation, *Linear algebraic equations, Polynomials, Matrices(Mathematics), Determinants, Algorithms, Computer programs, FORTRAN.
Identifiers: SAC-1 system.

The report is the tenth in a series of reports comprising the SAC-1 System for Symbolic and Algebraic Calculation. The present subsystem consists of programs implementing modular algorithms for linear equations solution, matrix inversion, determinant calculation, null space basis generation, and matrix multiplication, all for matrices with integer or polynomial entries. For each program in the system is given a functional specification, an algorithm description, an analytical computing time, and a Fortran program listing. Empirically observed computing times for some of the key programs are presented. Also, a test program is supplied as an aid in implementing the system and to illustrate its use. (Author)

PB-210 434/CP PC **A06**/MF **A01**
OHhio State Univ., Columbus. Computer and Information Science Research Center.
Optimum Center Location
Lee J. White, and Mark L. Gillenson. Jan 72, 116p Rept no. OSU-CISRC-TR-72-1
Grant NSF-GK-5256

Descriptors: *Graph theory, Algorithms, *Telecommunication, Network flows, Trees(Mathematics), Mathematical programming, Computer programs, Mathematical logic, Theorems, FORTRAN.

Consider N computer locations which require access to blocks of data. In this situation, a tradeoff always exists between storage and transmission costs. The proposed research deals with this design problem of optimum data allocation, as well as the related problem of the location of service centers, and uses a graphtheoretic model in order to systematically examine possible alternatives. The model examined is that of a star subgraph in a graph G in which both edges and vertices are weighted, and where a star subgraph of minimum cost is desired. The author has shown that in the case of equal vertex costs, an efficient algorithm for minimum k-covers of G offers a complete solution or good lower bound for the star subgraph problem. Recent results show that systematic movement from one star subgraph to another is possible by means of alternating paths. It is proposed to explore this relationship in order to construct an efficient algorithm for the star subgraph problem. (Author)

PB-210 782/CP PC **A05**/MF **A01**
Illinois Univ., Urbana. Dept. of Computer Science.
Stability and Convergence of General Multistep and Multivalue Methods with Variable Step Size
Kai-Wen Tu. Jul 72, 90p Rept no. UIUCDCS-R-72-526

Descriptors: *Boundary value problems, Approximation, *Numerical integration, Computer programs, Convergent series, Interpolation, Matrices(Mathematics), Theorems, Theses.
Identifiers: Multistep methods.

In the thesis the author is concerned with variable step size multistep methods which are generalizations of the summation from i = 0 to k of ((alpha sub i) (y sub n-i) + h(beta sub i) (f sub n-i)) = 0. (Author)

PB-210 856/CP PC **A04**/MF **A01**
Illinois Univ., Urbana. Dept. of Computer Science.
An Algorithm for the Solution of a Quadratic Equation Using Continued Fractions
Research rept.
Kishor Shridharbhai Trivedi. Jun 72, 67p Rept no. UIUCDCS-R-72-525
Grant NSF-GJ-813

Descriptors: *Quadratic equations, Algorithms, *Computer programming, Arithmetic, Continued fractions, Binary digits, Computer programs, FORTRAN, Theses, Theorems.

The report is an effort to investigate representations of numbers other than positional notation for computer arithmetic. Using continued fraction representation of numbers, an algorithm to solve a limited class of quadratics has been developed. This algorithm is suitable for hardware implementation and is reasonably efficient. Feasibility of constructing an arithmetic unit with continued fraction representation depends on discovery of many more such useful algorithms which can share the same hardware. (Author)

PB-212 767/8CP PC **A13**/MF **A01**
Cornell Univ., Ithaca, N.Y. Dept. of Operations Research.
Analytical Methology and Optimal Control in Urban Traffic Networks. Volume II
Final rept.
Robert Bechhofer, Mark Brown, Stella Dafermos, Mark Eisner, and James Little, Jr. Dec 68, 293p Rept no. TR-59
Contract FH-11-6913
See also Volume 3, PB-212 768.

Descriptors: *Urban transportation, Transportation models, *Transportation models, Network flows, *Vehicular traffic control, Automatic control, Queueing theory, Traffic lights, Highways, Mathematical models, Computer programs.

The report is the second in a series on automatic vehicular traffic control in urban transportation.

PB-212 769/4CP PC **A12**/MF **A01**
Cornell Univ., Ithaca, N.Y. Dept. of Operations Research.
Analytical Methodology and Optimal Control in Urban Traffic Networks. Volume IV
Final rept.
Robert Bechhofer, Mark Brown, Stella Dafermos, Mark Eisner, and James Little, Jr. Feb 71, 266p
Contract FH-11-6913
See also volume 1, PB-212 766.

Descriptors: *Urban transportation, Transportation models, *Transportation models, Network flows, *Vehicular traffic control, Automatic control, Traffic lights, Queueing theory, Intersections, Stochastic processes, Mathematical models, Computer programs.

The report is the final volume of a study on automatic vehicular traffic control in urban transportation.

PB-213 061/5CP PC **A04**/MF **A01**
Wisconsin Univ., Madison. Dept of Computer Sciences.
The SAC-1 Polynomial Factorization System
Technical rept.
G. E. Collins, and D. R. Musser. Mar 72, 69p
Rept no. WIS-CS-157-72
Grant NSF-GJ-239, NSF-GJ-30125
Also pub. as Madison Academic Computing Center, Wis., Technical rept. no. 30.

Descriptors: *Computer programming, Algorithms, *Polynomials, Computation, FORTRAN, List processing languages, Set theory, Binary digits, Computer programs, Theorems.
Identifiers: SAC-1 system, UNIVAC 1108 computers.

The SAC-1 Polynomial Factorization System is the ninth subsystem of the SAC-1 System, a Fortran system for performing operations on multivariate polynomials and rational functions with exact, infinite-precision coefficients. The SAC-1 Polynomial Factorization System provides efficient algorithms and subprograms for the factorization of univariate integral polynomials into their irreducible divisors using, most notably, Berlekamp's algorithm and Hensel's Lemma. For each algorithm there is given a semi-formal description, its theoretical computing time, and a Fortran IV program listing. Tables of observed computing times are given for the factorization of representative polynomials of degrees up to 20 with coefficients up to 6 decimal digits, the computing times on a UNIVAC 1108 ranging up to about 30 seconds. (Author)

PB-213 188/6CP PC **A07**/MF **A01**
National Institutes of Health, Bethesda, Md. Div. of Computer Research and Technology.
Transformation of Observed Distributions to Gaussian Form
Final rept.
David L. DeMets, and Eugene K. Harris. Jul 72, 135p Rept no. DCRT-TR-8

Descriptors: *Normal density functions, Transformations, Skewed density functions, Kurtosis, Trigonometric functions, Subroutines, FORTRAN, Biometrics, Computer programs.

Identifiers: IBM 360/370 computers.

Many clinical variables do not show gaussian distributions when measured in a sample of clinically normal healthy individuals. Instead of having the symmetric bell-shaped form characteristic of the Gaussian curve, the distributions often have long tails (skewness), and flat or peaked tops (kurtosis). Nevertheless, procedures which assume a gaussian distribution are often used to estimate normal ranges and percentiles of sample values. When the true distribution is not Gaussian, such estimates maybe highly inaccurate, particularly when substantial skewness is present. Unfortunately, the exact form of the underlying distribution is usually not known. The report describes a method and computer programs which preserves the power of gaussian-based statistical analysis without assuming that the original variable necessarily follows the gaussian distribution. (Author)

PB-213 395/8CP PC **A05**/MF **A01**
Illinois Univ., Urbana. Dept. of Computer Science.
A Study of the Effect of Additional Inequalities in Integer Programming for Logical Design
Masters thesis
Jose Joaquin Mora-Tovar. Oct 72, 87p Rept no. UIUCDCS-R-72-543
Contract NSF-GJ-503

Descriptors: *Linear programming, Inequalities, *Logic design, Optimization, Logic circuits, Gates(Circuits), Computer programming, Mathematical models, Theses.
Identifiers: *Integer programming.

In logical design of optimal networks by integer programming, additional inequalities are added in order to speed-up the computations time. The effects of different types of these additional inequalities for several logical design cases is studied. (Author)

PB-214 219/8CP PC **A05**/MF **A01**
Bureau of Mines, Washington, D.C.
Delineation of Clustered Points in Two Dimensions by Measuring Perimeters of Convex Hulls
Rept. of investigations 1971-1972
John H. Schuenemeyer, Charles E. Lienert, and George S. Koch, Jr. Dec 72, 77p Rept no. BuMines-RI-7565
Prepared in cooperation with Bureau of Mines, Denver, Colo. Div. of Mine Systems Engineering.

Descriptors: *Convex sets, *Clumps, Statistical analysis, Graphic methods, Clustering, Random processes, Polygons, Applications of mathematics, Geology, Geochemistry, Dust control, Computer programs, FORTRAN.
Identifiers: Convex hulls, FORTRAN 4 programming language, *Cluster analysis.

The report considers a set of points, some of which are anomalous (larger than a specified cutoff value), located on a plane. Whether some or all of these points are clustered to form one or more anomalies or, alternatively whether these points are scattered at random, may be investigated by measuring perimeters of the convex hulls - the smallest convex polygon that will encompass a group of points. A set of anomalous points is selected, and the perimeters of the convex hulls of this set and all its subsets are measured and compared with tabulated values of perimeters for each subset size. The report covers applications in several fields of geology and geochemistry, including geochemical exploration surveys and heavy mineral spatial distributions, as well as in mining (dust control) and medical geography. (Author)

PB-214 359/2CP PC **A03**/MF **A01**
Geological Survey, Arlington, Va.
Rosenbrock Technique for Determining Greatest or Least Value of a Function
Final rept.
P. H. Carrigan, Jr. Sep 72, 37p USGS-Computer Contrib-21, USGS-WRD-73-001

Descriptors: *Functions(Mathematics), Optimization, *Computer programs, Programming manuals, Matrices(Mathematics), Steepest decent method, FORTRAN, PL/1 Programming language, Subroutines, Mathematical programming.
Identifiers: FORTRAN 4 Programming language, IBM 360/65 computers, PL/1 Programming language.

In the FORTRAN 4 subroutine OPTRSN, the minimum of a function U = f (x sub k); k=1,...,n) is sought by sequential adjustment of the variables (x sub k). These independent variables may be bounded and other external constraints may be imposed. The maximum of a function may be found by defining the minimum being sought by OPTRSN as U = 1 / f (x sub k); k=I,...,n) or U = C - f(x sub k); k=I,...,n), C being a large constant. The search process for a minimum is terminated after a preselected number of adjustments to each variable is made. The program user has the option of following the search for a minimum. The report includes listings for FORTRAN and PL/1 versions of the subroutine written for the IBM 360/65. (Author)

PB-214 612/4CP PC **A06**/MF **A01**
Stanford Univ., Calif. Stanford Electronics Labs.
Subproblem of the m x n Sequencing Problem
Technical rept. no. 48
Henry Raymond Bauer. Nov 72, 123p Rept nos. STAN-CS-72-324, SU-SEL-72-057
Grant NSF-GJ-1180

Descriptors: *Sequencing, Mathematical models, *Computer programming, Sequencing, Scheduling, Algorithms, Compilers, Parallel processors, Trees(Mathematics), Matrices(Mathematics), Set theory, Queueing theory, Theorems, Theses.

Assume that a set of n tasks is to be scheduled on m processors. Each task is indivisible, and each processor may be concerned with only one task at a time. Then the m x n sequencing problem is to find the schedule in which the total completion time for all tasks is minimal. In addition, the author seeks an algorithmic solution which is efficient; that is, the computation must grow algebraically with the size of the problem rather than combinatorially. The results presented concern three separate families of subproblems. The first problem is an extension of the problems if Hu, and Coffman and Graham. Here we develop an algorithm for the optimal sequencing of n 1-unit and 2-unit tasks with tree precedence on two processors. The second family of problems concerns the sequencing of tasks on two processors where the tasks consist of chains of operations with known lengths. The algorithms for the third family of problems follow the work of Arthanari and Mukhopadhyay, and Szwarc. In this case, the author treats m, m = or > 4, processors and tasks formed by chains of m operations. Each of the operations corrsponds to each of the processors, in order. Some systems programming problems from computer science have characteristics similar to these subproblems.

PB-218 929/8CP PC **A04**/MF **A01**
Stanford Univ., Calif. Stanford Electronics Labs.
An Efficient Implementation of Edmonds' Maximum Matching Algorithm
Technical rept. no. 31
Harold Gabow. Jun 72, 74p Rept nos. SU-SEL-72-026, STAN-CS-72-328
Grant NSF-GJ-1180

Descriptors: *Graph theory, Matching, Search theory, Algorithms, Mathematical programming, Scheduling, Computer programming, Computation, Computer programs, Network flows.
Identifiers: Integer programming, Matching problem, NSF.

A matching in a graph is a collection of edges, no two of which share a vertex. A maximum matching contains the greatest number of edges possible. The paper presents an efficient implementation of Edmonds' algorithm for finding maximum matchings. The computation time is proportional to (V sup 3), where V is the number of vertices; previous algorithms have computation time proportional to (V sup 4). The implementation avoids Edmonds' blossom reduction by using pointers to encode the structure of alternating paths. (Author)

PB-219 044/5CP PC **A02**/MF **A01**
Illinois Univ., Urbana. Dept. of Computer Science.
Calculation of GFSR Pseudorandom Number Binary Starting Matrix
W. H. Payne. Mar 73, 13p Rept no. UIUCDCS-R-73-567

Descriptors: *Computer programming, Pseudorandom sequences, *Pseudorandom sequences, Computation, Matrices(Mathematics), Shift registers, Algorithms, Computer programs, FORTRAN.
Identifiers: IBM 360 computers, UNIVAC 1108 computers, CDC 6400 computers, IUU.

The generalized feedback shift register (GFSR) pseudorandom number algorithm produces the same floating-point sequence of pseudorandom numbers on any computer. The algorithm requires a binary initialization matrix. A matrix, given both in octal and hexadecimal, for primitive polynomial, modulo 2, (x sup 98) + (x sup 27) + 1 is listed. The FORTRAN routine listed was checked on several computers including an IBM 360. (Author)

PB-221 164/7CP PC **A10**/MF **A01**
Stanford Univ., Calif. Dept. of Industrial Engineering.
Optimal Design of Transportation Networks with Fluctuating Demands. A Case in Multicommodity Networks Flows
Final rept.
Jose Luis Aburto Avila. Dec 72, 203p* RR-1, UMTA-CA-11-0008-72-1

Descriptors: *Urban transportation, *Transportation models, *Mass transportation, *Network flows, Benefit cost analysis, Linear programming, Trees(Mathematics), Routing, Economic analysis, Demand(Economics), Statistical analysis, Computer programs, Optimization, Digital computers, Algorithms.
Identifiers: Integer programming, Sensitivity analysis, Branch and bound method, Shortest route problem, UMTA.

The problem of designing a transportation network that will best satisfy expected demand for travel among a given set of centers of activity is formulated by identifying for each origin-destination pair, called a commodity of the transportation network, all the alternative routes for travel that meet prespecified criteria and which constitute the set of feasible paths. Modal choice is assumed to be a function of travel time and consequently the model generates expected demands for travel, over alternative routes of different length, from a probability distribution function of travel time associated with each origin-destination pair. (Modified author abstract)

PB-221 666/1CP PC **A02**/MF **A01**
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Soils.
A Procedure for Stepwise Regression Analysis
A. C. Oertel. 1973, 16p Rept no. Technical Paper-16
International Standard Book no. 0-643-00064-X.

Descriptors: *Regression analysis, Algorithms, Matrices(Mathematics), Computer programs, FORTRAN, Australia.
Identifiers: CSIRO.

The paper presents a stepwise procedure for multiple regression analysis that is suitable for use with concentrations of elements in soils (or any other analytical results). Two regression analyses are made for each set of data. One analysis gives only the values of the statistically significant coefficients when the non-significant variables are excluded, while the other is the conventional complete regression analysis. A description and a listing of a FORTRAN computer program implementing the procedure are appended. (Author)

PB-221 702/4CP PC **A02**/MF **A01**
Research Inst. of National Defence, Stockholm (Sweden).

Noniterative Estimation of a Nonlinear Parameter
Arne Bergstrom. Apr 73, 11p Rept no. FOA-4-B4059-M4
International Standard Book No. ISBN-91-7056-023-4.

Descriptors: *Matrices(Mathematics), Algorithms, Approximation, Computer programs, Sweden.
Identifiers: SWRIND.

An algorithm is described which solves the parameters x = (x1, x2, ..., xm) and p in an approximation problem Ax approximately = y(p), where the parameter p occurs nonlinearly in y. Instead of linearization methods, which require an approximate value of p to be supplied as a priori information, and which may lead to the finding of local minima, the proposed algorithm finds the global minimum by permitting the use of series expansions of arbitrary order, exploiting an a priori knowledge that the addition of a particular function, corresponding to a new column in A, will not improve the goodness of the approximation. (Author)

PB-222 099/4CP PC **A06**/MF **A01**
Stanford Univ., Calif. Dept. of Computer Science.
The LZ Algorithm to Solve the Generalized Eigenvalue Problem
Technical rept.
Linda C. Kaufman. May 73, 103p Rept no. STAN-CS-73-363
Grant NSF-GJ-29988

Descriptors: *Matrices(Mathematics), Algorithms, Eigenvalues, Error analysis, Theorems, Computer programs, Permutations.
Identifiers: NSF.

The LZ algorithm is a method for solving the generalized eigenvalue problem where one is given 2 square matrices A and B and asked to find the scalar lambda and the vector x such that Ax equals lambda Bx. In the paper the author analyses certain aspects of the LZ algorithm and discuss various alternative approaches to different parts of the algorithm. In particular the author performs a backward error analysis of the algorithm and discusses various shift strategies and criteria for convergence. Several direct methods are described which may be substituted for the first phase of the LZ method where A is reduced to upper Hessenberg form and B to upper triangular form. (Author)

PB-222 513/4CP PC **E04**/MF **A01**
Stanford Univ., Calif. Dept. of Computer Science.
High Order Finite Difference Solution of Differential Equations
Technical rept.
Victor Pereyra. Apr 73, 89p Rept nos. STAN-CS-348-73, SU-326P30-26
Grant NSF-GJ-35135

Descriptors: *Nonlinear differential equations, *Finite difference theory, Boundary value problems, Numerical analysis, Computer programs, FORTRAN, Asymptotic series, Meetings.
Identifiers: Two point boundary value problems, FORTRAN 4 programming language, NSF.

These seminar notes give a detailed treatment of finite difference approximations to smooth nonlinear two-point boundary value problems for second order differential equations. Consistency, stability, convergence, and asymptotic expansions are discussed. Most results are stated in such a way as to indicate extensions to more general problems. Successive extrapolations and deferred corrections are described and their implementations are explored thoroughly. A very general deferred correction generator is developed and it is employed in the implementation of a variable order, variable (uniform) step method. Complete FORTRAN programs and extensive numerical experiments and comparisons are included together with a set of 48 references. (Author)

PB-222 859/1CP PC **A05**/MF **A01**
Stanford Univ., Calif. Dept. of Computer Science.
High Order Finite Difference Solution of Differential Equations
Technical rept.
Victor Pereyra. Apr 73, 89p Rept no. STAN-CS-73-348
Contract NSF-GJ-35135

Descriptors: *Nonlinear differential equations, Finite difference theory, *Boundary value problems, *Computer programs, Extrapolation, Approximation, Asymptotic series, FORTRAN.
Identifiers: Two point boundary value problems, FORTRAN 4 programming language, NSF.

These seminar notes give a detailed treatment of finite difference approximations to smooth nonlinear two-point boundary value problems for second order differential equations. Consistency, stability, convergence, and asymptotic expansions are discussed. Most results are stated in such a way as to indicate extensions to more general problems. Successive extrapolations and deferred corrections are described and their implementations are explored thoroughly. A very general deferred correction generator is developed and it is employed in the implementation of a variable order, variable (uniform) step method. Complete FORTRAN programs and extensive numerical experiments and comparisons are included together with a set of 48 references. (Author)

PB-223 897/0CP PC **E04**/MF **A01**
Stanford Univ., Calif. Dept. of Computer Science.
High Order Finite Difference Solution of Differential Equations
Technical rept.
Victor Pereyra. Apr 73, 89p Rept nos. STAN-CS-73-348, SU-326P30-26
Grant NSF-GJ-35135

Descriptors: *Boundary value problems, *Finite difference theory, *Nonlinear differential equations, Numerical integration, Approximation, Extrapolation, Matrices(Mathematics), Inequalities, Computer programs, Theorems, FORTRAN.
Identifiers: *Two point boundary value problems, NSF.

These seminar notes give a detailed treatment of finite difference approximations to smooth nonlinear two-point boundary value problems for second order differential equations. Consistency, stability, convergence, and asymptotic expansions are discussed. Most results are stated in such a way as to indicate extensions to more general problems. Successive extrapolations and deferred corrections are described and their implementations are explored thoroughly. A very general deferred correction generator is developed and it is employed in the implementation of a variable order, variable (uniform) step method. Complete FORTRAN programs and extensive numerical experiments and comparisons are included together with a set of 48 references. (Author)

PB-223 904/4CP PC **E04**/MF **A01**
Standford Univ., Calif. Dept. of Computer Science.
The LZ Algorithm to Solve the Generalized Eigenvalue Problem
Technical rept.
Linda Kaufman. May 73, 103p Rept no. STAN-CS-73-363
Grant NSF-GJ-29988

Descriptors: *Matrices(Mathematics), Algorithms, Eigenvalues, Transformations, Iteration, Error analysis, Computer programs, Theorems.
Identifiers: LZ algorithm, Hessenberg matrices, NSF.

The LZ algorithm is a method for solving the generalized eigenvalue problem where one is given two square matrices A and B and asked to find the scalar lambda and the vector x such that Ax = lambda Bx. In the paper, the author analyzes certain aspects of the LZ algorithm and discusses various alternative approaches to different parts of the algorithm. In particular, the author performs a backward error analysis of the algorithm and discusses various shift strategies and criteria for convergence. Several direct methods are described which may be substituted for the first phase of the LZ method where A is reduced to upper Hessenberg form and B to upper triangular form. (Author)

PB-226 091/7CP PC **A05**/MF **A01**
Arizona Univ., Tucson. Dept. of Systems Engineering.
Input Specifications to Stochastic Decision Models
Master's thesis
Deme Michael Clainos. 1972, 79p OWRR-A-024-ARIZ(8)
Contract DI-14-31-0001-3503

Descriptors: *Reservoirs, *Stochastic processes, *Decision theory, *Stream flow, *Water resources, Forecasting, Water supply, Industries, Irrigation, Computer programs, Hydroelectric power generation, Mathematical programming, Mathematical models, Theses.
Identifiers: OWRR.

The use of discrete conditional dependency matrices as input to stochastic decision models is examined. Some of the problems and initial assumptions involved with the construction of the matrices are discussed. Covered in considerable detail is the transform used to relate the gamma space with the normal space. A new transform is introduced that should produce reasonable results when the record of streamflows (data) has a highly skewed distribution. Finally, the possibility of using the matrices to provide realistic inputs to a stochastic dynamic program is discussed. (Author)

PB-226 187/3CP PC **E09**/MF **A01**
Kansas State Univ., Manhattan. Dept. of Industrial Engineering.
Optimization of Industrial Systems with the Separable Programming and the Generalized Reduced Gradient Methods
Master's thesis
Jerel L. Williams. 1972, 273p OWRR-A-038-KAN(4)
Contract DI-14-31-0001-3216

Descriptors: *Water quality, *Nonlinear programming, Optimization, Mathematical models, Computer programs, FORTRAN, Partial differential equations, Matrices(Mathematics), Theses.
Identifiers: Separable programming, Geometric programming, Duality theory, GREG computer program, OWRR.

Two nonlinear programming methods and their application to industrial systems are reviewed. Separable programming is described and exemplified. The same procedure is presented that is used in the separable programming subroutine of the Mathematical Programming System/360 (MPS/360). A supplemental FORTRAN program for assisting the usage of MPS/360 when solving separable programming problems is presented. An interesting application of separable programming to solve the geometric programming dual problem with N-degrees of difficulty is also exhibited. The second technique considered is the generalized reduced gradient method. The mathematical theory is presented and numerical examples are used to exemplify it. Its application via the GREG program is evaluated, and numerous computer examples are worked. The study is concluded with the application of the technique to optimize a water quality control model.

PB-227 396/9CP PC **E07**/MF **A01**
Ohio State Univ., Columbus. Computer and Information Science Research Center.
Bandwidth Minimization, Reducibility Decomposition, and Triangularization of Sparse Matrices
Technical rept.
Paul Tiing Renn Wang. Sep 73, 171p Rept no. OSU-CISRC-TR-73-5
Grant NSF-GN-534.1

Descriptors: *Matrices(Mathematics), *Computation, Graph theory, Eignvalues, Eigenvectors, Computer programs, Mathematical programming, Theorems, Algorithms, Theses.
Identifiers: Sparse matrix, Triangular matrices, Computational complexity, NSFSIS.

The report gives a brief historical review of several important techniques for permuting sparse matrices into different structures such as block upper triangular form, bonded form, and almost upper tri-

angular form. These techniques and their problems are shown to be closely related to graph theory, especially the concepts of connectivity, reachability, covering, etc. After studying the existing algorithms for permuting sparse matrices, the author developed four algorithms to improve either the speed of computation or storage required and to overcome some difficulties in existing algorithms.

PB-231 285/8CP PC **A04**/MF **A01**
Bureau of Mines, Washington, D.C.
A Computer Program for Clustering Data Points on the Sphere
Information circular
Robert J. Shanley, and M. Ashraf Mahtab. 11 Mar 74, 63p Rept no. BuMines-IC-8624
Prepared by Denver Mining Research Center, Colo.

Descriptors: *Clustering, *Statistical analysis, *Computer programs, Algorithms, Mining, Spheres, Fractures(Materials).
Identifiers: HYBMODE computer program, BM.

The computer program, HYBMODE, has been developed to meet the need for a fast and economical method for clustering data points on the sphere. The algorithm used in this development is an extension of D. Wishart's one-level mode analysis. The program can be utilized in the analysis of either vectorial or axial data and is currently being used in the analysis of fracture orientations. (Author)

PB-231 821/0CP PC **A11**/MF **A01**
Wisconsin Univ., Madison. Dept. of Computer Sciences.
Algorithms for Polynomials Over a Real Algebraic Number Field
Technical rept.
Cyrenus M. Rubald. Jan 74, 233p Rept no. WIS-CS-206-74
Grant NSF-GJ-30125

Descriptors: *Field theory(Algebra), *Number theory, *Polynomials, *Computer programming, Computation, FORTRAN, Computer programs, Algorithms, Theorems.
Identifiers: SAC-1 system.

The report describes and analyzes algorithms for the arithmetic operations and the order relation in any ordered real algebraic number field Q(alpha). The real algebraic number alpha is specified as the unique zero of an integral primitive polynomial (not necessarily irreducible) in an isolating rational interval. Algorithms are also described and analyzed for arithmetic and greatest common divisor calculations in Q(alpha) (X). All algorithms are implemented in FORTRAN and the SAC-1 system.

PB-231 859/0CP PC **A03**/MF **A01**
Wisconsin Univ., Madison. Dept. of Computer Sciences.
Drum Models Using an Iterative Solution for Closed Queueing Networks
Technical rept.
J. H. Hine, and D. R. Fitzwater. Jan 74, 44p Rept no. WIS-CS-200-74

Descriptors: *Multiprogramming, *Queueing theory, Network flows, Parallel processors, Scheduling, Mathematical models, Algorithms.
Identifiers: Paging, WISCS.

An algorithm by Buzen to find the normalizing constant and marginal probabilities in a closed queueing network is generalized to the model of Muntz and Baskett. A technique involving the iterative solution of a closed queueing network to implement queue dependent completion time distributions is presented. An accurate model of a paging drum for queueing networks is given as an example. (Author)

PB-231 861/6CP PC **A04**/MF **A01**
Wisconsin Univ., Madison. Dept. of Computer Sciences.
The SAC-1 Modular Arithmetic System
Technical rept.
G. E. Collins, L. E. Heindel, E. Horowitz, M. T. McClellan, and D. R. Musser. Nov 72, 54p Rept no. WIS-CS-165-72
Contract NSF-GJ-30125, Grant NSF-GJ-239

Descriptors: *Computer programming, *Arithmetic, Computation, Chinese remainder theorem, Galois theory, Polynomials, Interpolation, Prime numbers, Algorithms, Computer programs, FORTRAN.
Identifiers: SAC-1 system, Greatest common divisors, Computational complexity, NSF.

The paper is a reprinting of the original report of June 1969, with correction of a few minor errors. The SAC-1 Modular Arithmetic System is the fifth of the ten SAC-1 subsystems which are now available. It provides subprograms for the arithmetic operations in a prime finite field GF (p), for any single-precision prime p, and for various operations on polynomials in several variables with coefficients in GF (p). Besides the arithmetic operations on such polynomials there are included subprograms for the Chinese remainder theorem, evaluation and interpolation. For univariate polynomials, subprograms are included for greatest common divisor calculation and Berlekamp's factorization algorithm. (Author).

PB-231 862/4CP PC **A04**/MF **A01**
Wisconsin Univ., Madison. Dept. of Computer Sciences.
The SAC-1 Integer Arithmetic System-Version III
Technical rept.
George E. Collins. 12 Mar 73, 67p Rept no. WIS-CS-156-73
Grant NSF-GJ-30125

Descriptors: *Computer programming, *Arithmetic, Computation, Addition, Subtraction, Multiplication, Division, Algorithms, Computer programs, FORTRAN.
Identifiers: SAC-1 system, Greatest common divisors, Computational complexity, NSF.

The report documents a new version of the SAC-1 Integer Arithmetic System, a system for performing arithmetic operations and input-output on infinite-precision integers. The new version contains improved algorithms for base conversion and some new subprograms. However, the most important improvement is the documentation provided by this report, which includes, for each subprogram, a functional specification, a semi-formal algorithm description, both theoretical and empirical computing times, and an ANSI standard FORTRAN program listing which corresponds closely to the algorithm description. (Author)

PB-231 882/2CP PC **A04**/MF **A01**
Wisconsin Univ., Madison. Dept. of Computer Sciences.
Discrete Mechanics - A General Treatment
Technical rept.
Robert A. LaBudde, and Donald Greenspan. Dec 73, 75p Rept no. WIS-CS-192-73

Descriptors: *Classical mechanics, *Many body problem, *Equations of motion, *Numerical analysis, Potential theory, Vector analysis, Computer programs.
Identifiers: WISCS.

A new numerical method for use in the solution of classical equations of motion is described, accurate to third-order in the coordinates and second-order in the velocities. The method has the unique property of preserving the energy and total linear and angular momenta at their initial values in the computation. This 'discrete mechanics' is derived from general symmetry properties of the equations of motion and is compared in several numerical examples with conventional predictor-corrector methods. The theory is applied to derive a general expression for the impulsive limit of motion due to a potential. (Author)

PB-232 113/1CP PC **A06**/MF **A01**
Bureau of Radiological Health, Rockville, Md. Office of Data Systems and Mathematics.
General Tabulation System (GT), Computer Programs, User's Guide
Sheppard Yarrow. Dec 73, 106p* Rept no. FDA/DF-73-008a
Revision of report dated 1968. For magnetic tape, see PB-232 114.

Descriptors: *Computer programming, *Statistical analysis, *Tabulation processes, Standard deviation, Frequency distribution, Mean, Control sequences, Tables(Data).
Identifiers: General tabulation system, GT computer program.

The document describes the General Tabulation (GT) Program. It is one of five programs within the General Tabulation System. The GT program itself produces the basic table. The first portion of the document addresses itself to a general description of how a table is constructed and what options are available to the user. Part Two explains in detail how to set up a computer run to yield the desired tables. Part Three contains technical information concerning how the GT program has been implemented at the computer facility, and discusses the technical limitations thus imposed. Finallly Part Four is a glossary of terms used throughout the document. An accompanying diagram serves to clarify several of the definitions.

PB-232 114/9CP CP **T03**
Bureau of Radiological Health, Rockville, Md. Office of Data Systems and Mathematics.
General Tabulation System (GT)-Computer Program, IBM 360 Assembly Language
Data file
Stuart Carlow, Neil Goldstein, and Sheppard Yarrow. 1968, 1 reel mag tape Rept no. FDA/DF-73-008
Specify tape recording mode desired: 7 track, 556 and 800 BPI, odd and even parity, BCD; or 9 track, 800 BPI, odd parity, EBDCIC. Price includes documentation, PB-232 113.

Descriptors: *Computer programming, *Statistical analysis, *Tabulation processes, *Magnetic tapes, Standard deviation, Frequency distribution, Mean.
Identifiers: General tabulation system, GT computer program.

The GT software system consists of five major components, the basic component being the General Tabulation Program itself. This program is designed to compute one or more of three types of tables: frequency distributions, weighted frequency distributions, and a table of sums of squares of weighted frequencies. The output from this program can be input to a means program, a standard deviations program, a percents program or a headers program. Aside from the ability to produce statistical tabulations on the input file itself, the system affords the additional flexibility of allowing the user to modify any record prior to its being processed by the General Tabulations Program.

PB-234 099/0CP PC **E03**/MF **A01**
Illinois Univ., Urbana. Dept. of Computer Science.
Interactive Express Statistical System
Master's thesis
William Charles Walter. Jun 74, 55p Rept no. UIUCDCS-R-74-653

Descriptors: *Statistical analysis, *Computer programs, Time sharing, Computation, Data processing, Subroutines, Theses.

The need for easy to use statistical systems have grown rapidly in recent years. Interactive Express Statistical System (I.E.S.S.) combines the fast turnaround of the Express job system with the conversation capabilities of Call-OS FORTRAN on the PLORTS time-sharing system. It provides an instructive and easy to use tool for many statistical analyses. The paper deals with design considerations during the development of I.E.S.S., with emphasis on the implementation language and interaction between the PLORTS and Express systems. Examples of usage, sample segments of code, and message file structures are taken from the Correlations-Factor Analysis statistical area.

PB-237 966/7CP PC **A02**/MF **A01**
British Steel Corp., Sheffield (England). Information Services.
Design of Balanced Experiments with Continuous Variables - Mathematical and Programming Aspects
A. A. Greenfield. Jul 74, 21p Rept no. MG/57/71

Descriptors: *Experimental design, Combinatorial analysis, Factorials, Computer programs, Great Britain.

This report presents in detail the mathematical and programming approach that has been adopted for the automatic design of experiments with continuous variables and has been written in support of the users' appreciation manual already published. The classes of design tackled are two-level fractional factorials and their extension into composite orthogonal designs for the estimation of quadratic effects.

PB-238 581/3CP PC **A06**/MF **A01**
Cornell Univ., Ithaca, N.Y. Dept. of Computer Science.
A Class of Derivative-Free Algorithms for Unconstrained Minimization
Technical rept.
Ann-Sheng A. Chien. Aug 74, 125p Rept no. CU-CSD-74-220
Grant NSF-GJ-27528

Descriptors: *Functions(Mathematics), *Approximation, Algorithms, Matrices(Mathematics), Finite difference theory, Theorems, Computer programs, Theses.

This thesis is concerned with the problem of calculating the least value of a given function f(x), x = (x1, x2, ...xn), in the case that only values of f are available. One expects that f is twice continuously differentiable but one may suppose that it is preferable not to calculate even one derivative.

PB-239 432/8CP PC **A07**/MF **A01**
California Univ., Los Angeles.
Solution of Simultaneous Partial Differential Equations: An Extension of PDEL
Master's thesis
Eileen Siu-ha Choi. 1973, 133p OWRT-B-150-CAL(6)

Descriptors: *Computer programming, *Partial differential equations, *Numerical integration, Digital simulation, Simulation languages, Elliptic differential equations, Hyperbolic differential equations, Parabolic differential equations, Computation, Theses.
Identifiers: PDEL programming language.

The capability of PDEL (Partial Differential Equation Language) is extended to solve simultaneous partial differential equations. Specifically, a new portion of the PDEL translator is designed to handle simultaneous 1-, 2-, and 3-dimensional elliptic, parabolic and hyperbolic equations and to actually implement the model for solving simultaneous 2-dimensional parabolic equations. The extension is accomplished by modifying the existing partial differential equation solution algorithm to allow for incorporation of an ordinary differential equation solution module rather than by implementing entirely new and lengthy algorithms to PDEL.

PB-240 685/8CP PC **A04**/MF **A01**
Bureau of Mines, Denver, Colo. Denver Mining Research Center.
FRACTAN: A Computer Code for Analysis of Clusters Defined on the Unit Hemisphere
Information circular 1975
R. J. Shanley, and M. A. Mahtab. Feb 75, 54p Rept no. BuMines-IC-8671

Descriptors: *Mining engineering, *Cluster sampling, *Computer programs, Mineralogy, Crystallography, Clustering, Probability density functions, Statistical analysis.
Identifiers: FRACTAN computer code, CDC 6400 computers.

The report presents a computer code that has been developed for isolating naturally occurring clusters of data plotted on the unit hemisphere and testing these clusters against a probability distribution which admits elliptical symmetry about its mean. A listing of the computer code is provided along with an example output illustrating the delineation and analysis of clusters in fracture orientations measured in a porphyry copper deposit.

PB-242 157/6CP PC **A04**/MF **A01**
Carnegie-Mellon Univ., Pittsburgh, Pa.
A User Manual for Geometric Programming
Technical rept.
Abrahim Lavi. 15 Dec 74, 69p NSF/RANN/SE/GI-39114/TR/74-5, NSF/RA/N-74-199
Grant NSF-GI-39114

Descriptors: *Mathematical programming, Inequalities, Optimization, Computer programs, Programming manuals.
Identifiers: *Geometric programming, Duality theory.

Geometric programming as an optimization tool is explained in simple language with as few mathematical concepts as possible. A computer code for solving geometric programming problems is provided. This code was developed by Westinghouse Research and Development Center and was made available to CMU gratis. The steps to be followed in using the program are given in detail; sample problems are solved, and the computer output is displayed and explained.

PB-246 301/6CP PC **A03**/MF **A01**
National Bureau of Economic Research, Inc., Cambridge, Mass. Computer Research Center for Economics and Management Science.
Conference on Modeling Large-Scale Systems and Related Software Held at Vail, Colorado on 16-17 June 1975
Edwin Kuh. 17 Jun 75, 26p
Grant NSF-DCR75-16390

Descriptors: *Economic models, *Computer programming, *Mathematical programming, Meetings, Econometrics, Mathematical models, Linear programming, Nonlinear programming, Algorithms.

The conference on modeling large-scale systems and related software held at Vail Colorado, June 16-17, developed an agenda for research on problems associated with large-scale models and related software. Most of the recommendations were grouped under the following four headings: software development and accessibility, algorithms, large-scale models, and estimation. The rest of the report consists of the proceedings of the two day conference with summaries of the papers presented by the conference participants.

PB-251 156/6CP PC **A02**/MF **A01**
Geological Survey, Denver, Colo.
An Optimal Method for Evaluating a Class of Convolution Integrals with Related Kernels
Final rept.
Walter L. Anderson. 1976, 16p Rept no. USGS/GD-76/003

Descriptors: *Convolution integrals, *Computer programs, *Numerical integration, Fourier transformation, Hankel transformation, Digital filters, FORTRAN, Complex variables, Algorithms.

A FORTRAN 4 algorithm is described for optimally evaluating certain classes of convolution integrals containing related kernel functions. Specifically, Fourier (sine, cosine) or Hankel (J sub 0), (J sub 1) transforms with related input kernels are evaluated efficiently, and without loss of accuracy, using an extension of a digital filtering algorithm previously published by the author. The optimal method is accomplished by use of special written external subprograms, and therefore, does not require any modifications to the existing filter algorithms. This method is similar to lagged-convolution algorithms, and may be used as an alternative for problems in which lagged-convolution is not directly applicable. A simple FORTRAN coding example is given illustrating the essence of the new algorithm.

PB-258 428/2CP PC **A07**/MF **A01**
National Ocean Survey, Rockville, Md. Geodetic Research and Development Lab.
The Statistics of Residuals and the Detection of Outliers
Technical rept.
Allen J. Pope. May 76, 139p NOAA-TR-NOS-65, NGS-1, NOAA-76080320

Descriptors: *Geodetic surveys, *Statistical analysis, Least squares method, Triangulation, Tables(Data), Computation, Computer programs.
Identifiers: Residuals, Outliers.

Insofar as possible it is desirable to base the criteria for the detection of bad data on rigorous statistical arguments. This report recapitulates the statistics involved and describes the 'tau' criterion in detail. This criterion is especially suited for use in simulataneous least-squares adjustments of triangulation networks. Special note is taken of yet unsolved problems involved in the rigorous derivation of still more efficient and exact rejection criteria.

PB-261 121/8CP PC **A04**/MF **A01**
Transportation Systems Center, Cambridge, Mass.
Program MULTI - A Multi-Purpose Program for Computing and Graphing Roots and Values for Any Real Function. Users/Programmers Manual
Final rept. Jul-Dec 75
Russel Brantman. May 76, 54p* DOT-TSC-FRA-76-1, FRA/ORD-76/143

Descriptors: *Real variables, *Computer programs, *Curve fitting, *Computation, Roots of equations, Degrees of freedom, Interpolation, Plotting, FORTRAN, Programming manuals.
Identifiers: *MULTI computer program, Bifurcation theory.

A generalized multi-purpose program has been developed that can be used to compute and graph cross sections of any surface in space, or to compute and graph the roots of any equation and any functions of these roots. It can therefore be used for a variety of applications, including the graphing of multi-valued functions whose branches are not known beforehand. This capability is unique among graphing programs, and it greatly facilitates the analysis of any system with multiple equilibrium branches. The program is especially suited for computing the equilibrium branches and investigating the stability o nonlinear finite-degree of freedom systems subjected to static loads. The program is oriented towards systems with one or two degrees of freedom, but it can also handle additional degrees of freedom and any number of parametric variables.

PB-261 814/8CP PC **A03**/MF **A01**
Stanford Univ., Calif. Dept. of Computer Science.
Calculation of Interpolating Natural Spline Functions Using de Boor's Package for Calculating with B-Splines
Technical rept.
John G. Herriot. Oct 76, 49p Rept no STAN-CS-76-569
Grant NSF-MCS71-01996-A06

Descriptors: *Interpolation, *Computer programs, FORTRAN, ALGOL, Algorithms, Subroutines.
Identifiers: *Spline interpolation, *Spline functions.

A FORTRAN subroutine is described for finding interpolating natural splines of odd degree for an arbitrary set of data points. The subroutine makes use of several of the subroutines in de Boor's package for calculating with B-splines. An ALGOL W translation of the interpolating natural spline subroutine and of the required subroutines of the de Boor package are also given. Timing tests and accuracy tests for the routines are described.

PB-261 842/9CP PC **A13**/MF **A01**
California Univ., Los Angeles. School of Engineering and Applied Science.
A Computer-Oriented Approach to Fault-Tree Construction
S. L. Salem, G. E. Apostolakis, and D. Okrent. Apr 76, 287p UCLA-ENG-7635, NSF/RA-760320
Grant NSF-GI-39416, NSF-OEP75-20318

Sponsored in part by Electric Power Research Inst., Palo Alto, Calif. Part of a Study: A General Evaluation Approach to Risk-Benefit for Large Technological Systems and Its Application to Nuclear Power.

Descriptors: *Reliability, *Systems design, *Computer programs, *Safety engineering, Aviation safety, Nuclear reactor safety, Mathematical models, Risk, Sampling.
Identifiers: *Fault tree analysis, CAT computer program.

To insure the safe and efficient operation of a complex system, it is necessary to consider the ways in which equipment can malfunction as well as the possible outcomes of each different mode of failure. This study attempts a further step in the systematic application of mathematical techniques to the problem of improving both qualitative and quantitative methods of analyzing the safety of large systems. Objectives are to: (1) develop a methodology for the systematic construction of fault trees; (2) apply this methodology in developing a computer code for the automated construction of fault trees; and (3) to apply the code to representative systems. This dissertation includes the basic methodology, the fundamental concept of the approach of modeling component behavior in a system via decision tables, and a step-by-step example of how a fault tree can be constructed by hand. The results of two applications are presented and commented upon. The computer code is presented in five appendices.

PB-262 038/3CP PC **A04**/MF **A01**
Notre Dame Univ., Ind. Dept. of Aerospace and Mechanical Engineering.
Improved Techniques for Simulation Experimentation with Multiple-Response Stochastic Processes
Final rept.
William E. Biles. 9 Dec 76, 66p
Grant NSF-ENG74-19313-A01
Work continuing under contract N00014-76-C-1021.

Descriptors: *Digital simulation, *Optimization, *Stochastic processes, *Systems engineering, Monte Carlo method, Search theory, Simplex method, Algorithms.
Identifiers: Response surface analysis, Constrained optimization.

This report describes and evaluates several optimization methods for application to simulation models which yield multiple responses. It examines two formulations of the multiple-response simulation problem: (1) constrained optimization; and (2) multiple objective optimization. Three classes of optimization methods are examined: (1) direct search methods, including random search, pattern search, sequential simplex search, and complex search; (2) first-order response surface methods; and (3) second-order response surface methods. For each of these optimization methods, the effects of such factors as point spacing, replication, and the level of random error are assessed, using four test problems with known solutions. The results of this study reveal several effective and efficient optimization methods for application to multiple-response simulation.

PB-262 243/9CP PC **A06**/MF **A01**
Utah Water Research Lab., Logan.
User Oriented Systems Analysis for Regional Municipal Water Supply Planning
Paul E. Pugner, and Trevor C. Hughes. Jul 76, 111p PRWA23-1, OWRT-B-125-UTAH(2)
Contract DI-14-34-0001-6127

Descriptors: *Water supply, *Regional planning, *Municipal engineering, *Systems engineering, Optimization, Linear programming, Stochastic processes, Computer programs, Algorithms.
Identifiers: Mixed integer programming.

An interactive data and model generator is developed that is intended to bridge the gap between planning engineers and the mathematical programming systems approach to municipal and regional water supply planning. The optimization objective is to minimize total annual cost of existing and future alternative source-related water supply facilities with respect to capital investment and operation and maintenance costs. A matrix generator is developed which formulates the necessary hydrologic, demographic and stochastic municipal water supply data into the format of a mixed integer linear programming problem for system optimization. The program then calls the integer programming algorithm, solves the optimization problem, and outputs a report in a format and language designed specifically for the problem at hand. All of this is accomplished in interactive mode with the user simply answering questions which are asked by the program.

PB-263 100/0CP PC **A09**/MF **A01**
National Bureau of Standards, Washington, D.C. Inst. for Materials Research.
A Numerical Solution of the Time Dependent Partial Differential Equations Which Describe a One-Dimensional, Laminar, Premixed Flame
Final rept.
R. L. Brown. Jan 76, 178p Rept no. NBSIR-76-994

Descriptors: *Flames, *Laminar flow, *Parabolic differential equations, *Numerical integration, *Computer programs, Partial differential equations, Combustion, One dimensional flow, Steady state.

The set of time dependent, parabolic differential equations, which describe the physical and chemical processes in a one-dimensional, laminar, premixed flame is solved by adapting a solution procedure originally developed to solve the two-dimensional steady state boundary layer equations. The flame equations are integrated by an implicit method until the steady state is reached. This corresponds to a flame propagating steadily through a mixture of combustible gases. By a suitable choice of boundary conditions, it is also possible to model a flame which is stabilized on a burner. Solution of the flame equations yields the concentration profiles of the different chemical species as well as the temperature profile. From these one can also calculate the production rates of each species, the rate of each chemical reaction, and the heat release rate at each point in the flame. The velocity of the freely propagating flame can be calculated from the integrals over the whole flame zone of any of the species production rates. The model incorporates realistic thermodynamic data and transport property data that are functions of both temperature and concentration. A complete documentation of the computer program which accomplishes the integration is presented.

PB-263 474/9CP CP **T99**
Statistical Reporting Service (USDA), Washington, D.C. Systems Branch.
SYSTEM 4204 - A Generalized Series of Summary Programs Generating Direct Expansions, Standard Errors, Coefficients of Variation and Correlation Coefficients
Software
Lawrence A. Gambrell. Aug 73, mag tape USDA/DF-77/001
Source tape is in EBCDIC character set. Tape(s) can be prepared in most standard 7 or 9 track recording modes for one-half inch tape. Identify recording mode desired by specifying character set, track, density, and parity. Call NTIS Computer Products if you have questions.(CP T99)

Descriptors: *Statistical analysis, *Software, *Computer programs, Sampling, Estimates, Magnetic tapes.
Identifiers: Fortran 4 programming language, Hasp operating system, IBM 370/168 computers.

The system 4042 accepts expanded data from either 1 or 2 probability sample frames, computes direct expansion estimates and standard errors at each summary level, and weighs these estimates into a single combined estimate. The system is written in the Fortran 4 programming language for implementation on an IBM 370/168 computer using the OS version, Hasp level operating system. 168K, excluding buffers, bytes of core storage are required to operate the model.

PB-263 498/8CP PC **A07**/MF **A01**
National Center for Atmospheric Research, Boulder, Colo.
Efficient FORTRAN Subprograms for the Solution of Elliptic Partial Differential Equations
Technical note
Paul Swarztrauber, and Roland Sweet. Jul 75, 147p Rept no. NCAR/TN-109+IA
Contract NSF-C760

Descriptors: *Elliptic differential equations, *Numerical integration, *Computer programming, Partial differential equations, Atmospheric circulation, Mathematical models, Computation, FORTRAN, Subroutines.
Identifiers: Helmholtz equation.

The numerical solution of elliptic partial differential equations in computer models of atmospheric processes can be a formidable programming task. But with recent advances in computing methods, a very large class of elliptic equations can be solved rapidly and with minimal storage. This report describes seven Fortran subroutines and contains an appendix dealing with solutions of linear systems of equations. Five subroutines solve a Helmholtz equation in various coordinate systems; they solve two-dimensional problems, but can be adapted for use in three-dimensional problems. The other two subroutines can solve a more general class of equation.

PB-264 306/2CP CP **T04**
National Cancer Inst., Bethesda, Md. Lab. of Theoretical Biology.
SAAM27, Simulation, Modeling and Data Fitting Program for UNIVAC
Model-Simulation
Mones Berman, and Marjory Weiss. 23 Feb 77, mag tape NIH/DF-77/001
Supersedes PB-256 467.
Source tape is in FIELDATA character set. Character set restricts preparation to 7 track, one-half inch tape only. Identify recording mode by specifying density and parity only. Call NTIS Computer Products, if you have questions. Price includes documentation, PB-238 368 and PB-256 468.

Descriptors: *Models-Simulation, *Mathematical models, *Computer programming, Magnetic tapes, Computerized simulation, Fortran, Programming manuals, Nonlinear differential equations, Integral equations, Theory of equations, Computation, Curve fitting.
Identifiers: *Saam 27 computer program, Biological models, IBM 370 computers, Univac 1108 computers.

Saam is a computer program designed as a tool for the study and testing of mathematical models. Although designed originally for the modeling of biological systems any set of mathematical equations (differential, integral or algebraic) or functions may serve as a model provided an analytical or numerical procedure exists for its solution. A library of model types, including ordinary non-linear differential equations, is incorporated within the program for routine use. The program uses a common data input format for all model types. This is made possible through the use of a single set of computational parameters and variables in the program. The number of entries required to specify a model and its constraints has been minimized to simplify use. Considerable effort was made to develop a simple correspondence between biological systems, experimental techniques and the Saam simulation language. In routine use an absolute version of Saam is maintained on drum, disc or tape and brought in for execution through job control cards. A 'run' consists of the job control cards needed for job termination. Each problem deck is self-contained in that it has all the information necessary to proceed with execution by Saam. The program was written in the Fortran programming language for implementation on a Univac 1108 computer using the Exec 8 operating system. 64K words of core storage are required to operate the model.

PB-265 274/1CP PC **A03**/MF **A01**
National Oceanic and Atmospheric Administration, Boulder, Colo. Wave Propagation Lab.

Computer Programs for Maximum Entropy Spectral Analysis of Real and Complex Single-Channel Time Series (with Microfilm Plots)
Technical memo.
Otto Neal Strand, Jessie M. Young, and Russell B. Chadwick. Feb 77, 43p NOAA-TM-ERL-WPL-19, NOAA-77030802

Descriptors: *Computer programming, *Time series analysis, *Spectrum analysis, Entropy, Algorithms, Fourier transformation, Fortran.
Identifiers: Fast Fourier transform.

Various Fortran computer programs are described for maximum entropy spectral analysis of a single real or complex time series. The descriptions are in sufficient detail to permit the methods to be correctly implemented. All programs have been carefully checked out, and are available from the authors on request.

PB-266 381/3CP PC **A04**/MF **A01**
Stanford Univ., Calif. Dept. of Computer Science.
On Computing the Singular Value Decomposition
Technical rept.
Tony Fan C. Chan. Aug 76, 61p Rept no. STAN-CS-77-588
Grant NSF-DCR75-13497

Descriptors: *Matrices(Mathematics), *Computation, *Decomposition method, Algorithms, Computer programs, Fortran.
Identifiers: Householder transformation, Golub-Reinsch algorithm.

The most well-known and widely-used algorithm for computing the Singular Value Decomposition (SVD) of an m x n rectangular matrix A nowadays is the Golub-Reinsch algorithm. In this paper, it is shown that by (1) first triangularizing the matrix A by Householder transformations before bidiagonalizing it, and (2) accumulating some left transformations on an n x n array instead of on an m x n array, the resulting algorithm is often more efficient than the Golub-Reinsch algorithm, especially for matrices with considerably more rows than columns ($m >> n$), such as in least squares applications. The two algorithms are compared in terms of operation counts, and computational experiments that have been carried out verify the theoretical comparisons.

PB-269 148/3CP CP **T18**
Forest Service, Albuquerque, N. Mex. Computer Science Staff.
Polynomial Regression Analysis.
Software.
22 Jul 76, mag tape SW-98881088, USDA/DF-77/005
Source tape is in EBCDIC character set. Tape(s) can be prepared in most standard 7 or 9 track recording modes for one-half inch tape. Identify recording mode desired by specifying character set, track, density, and parity. Call NTIS Computer Products if you have questions.

Descriptors: *Natural logarithms, *Software, *Regression analysis, *Computer programs, Analysis of variance, Computation, Magnetic tapes.
Identifiers: Univac 1108 computers, Operating system = Exec 8, Software type = Computer program, Batch processing mode, System application = Scientific/engineering, Fortran programming language, Computer memories = 10k, Program statements = 1k, Tape drives = one, Other = Card reader.

The program calculates first, second, and third degree regression equations in arithmetic and natural logarithms of Y and X. The program has provisions for giving different significance to values based upon frequency and/or inverse or variance. Prints scatter diagrams with automatic or user-supplied scaling.

PB-269 149/1CP PC **A02**/MF **A01**
Forest Service, San Francisco, Calif. Region 5.
Polynomial Regression Analysis, User's Guide
B. Cmaylo, and D. Chong. Apr 76, 14p* USDA/DF-77/005a
For system on magnetic tape see PB-269 148.

Descriptors: *Regression analysis, *Computer programming, Analysis of variance, Computation, Programming manuals.
Identifiers: Univac 1108 computers, Fortran 4 programming language, *Natural logarithms.

The Polynomial Regression Analysis Program calculates first, second and third degree regression equations in arithmetic and natural logarithms of Y and X. The program has provisions for giving different significance to values based upon frequency and/or inverse or variance. Prints scatter diagrams with automatic or user supplied scaling.

PB-269 465/1CP CP **T10**
Agricultural Research Service, Beltsville, Md. Data Systems Application Div.
Generalized Analysis of Variance for Balanced Subclass Numbers.
Software.
2 Aug 76, mag tape SW-1401, USDA/DF-77/009
Includes documentation.
Source tape is in EBCDIC character set and certain fields contain packed decimal data. Character set restricts preparation in 9 track one-half inch tape only. Identify recording mode by specifying density only. Call NTIS Computer Products if you have questions.

Descriptors: *Analysis of variance, *Software, *Computer programs, Factorials, Computation, Magnetic tapes.
Identifiers: IBM 360 computers, IBM 370 computers, Software type = Computer program, Batch processing mode, System application = Scientific/engineering, ALC programming language, Computer memories = 48k, Program statements = 1021, Other = Card reader.

The program computes an analysis of variance for any factorial or pseudofactorial experiment where subclass numbers are balanced. All sources or any selected sources in the analysis of variance, including both cross classified and/or nested effects, are under parameter option. Also under parameter option are selected subclass means.

PB-269 466/9CP PC **A02**/MF **A01**
Agricultural Research Service, Beltsville, Md. Data Systems Application Div.
Generalized Analysis of Variance for Balanced Subclass Numbers, User's Guide
Leonie Penney. Nov 70, 16p USDA/DF-77/009a
For system on magnetic tape, see PB-269 465.

Descriptors: *Analysis of variance, *Computer programming, Factorials, Computation, Programming manuals.
Identifiers: IBM 360 computers, IBM 370 computers, ALC programming language.

The Generalized Analysis of Variance for Balanced Subclass Numbers program computes an analysis of variance for any factorial or pseudofactorial experiment where subclass numbers are balanced. All sources or any selected sources in the analysis of variance, including both cross classified and/or nested effects, are under parameter option. Also under parameter option are selected subclass means. The program can handle up to 8 main effects (with a maximum of 7500 lower line subclasses) and any number of variables. The sum of the levels of all effects cannot exceed 200.

PB-269 480/0CP PC **A07**/MF **A01**
Boeing Computer-Services, Inc., Seattle, Wash. Energy Technology Applications Div.
OPTREG - An Interactive Computer Program for Optimization and Regression
Final rept. Jun 73-Aug 76
Richard A. Erickson, Rosem Southall, David W. Twigg, and Yvonne Y. Wong. Jun 77, 141p BCS-G0792, DOT-HS-802-422
Contract DOT-HS-356-3-719

Descriptors: *Computer programming, *Regression analysis, Simplex method, Optimization, Programming manuals.
Identifiers: *Optreg computer program, CDC 6600 computers, KIT operating system, Fortran 4 programming language.

OPTREG is a computer program which provides stepwise multiple regression analysis and optimization of a user defined function by the geometric simplex method. Both optimization and regression are performed interactively. This gives the user visibility and quick response, as well as a high degree of control over the optimization and regression procedures. Because of the fine control over the optimization algorithm which is available, OPTREG is particularly well suited to optimization of a function which is expensive to evaluate. OPTREG is programmed in Fortran IV, and operates on the CDC 6600 under the Kronos Interactive Timesharing (KIT) operating system. This document is the user manual for the OPTREG program. The OPTREG features are described, examples are given, and KIT control card sets performing the various OPTREG options are provided.

PB-269 487/5CP CP **T18**
Agricultural Research Service, Beltsville, Md. Data Systems Application Div.
Potency Probit Analysis.
Software.
2 Aug 76, mag tape SW-1702, USDA/DF-77/008
Includes documentation.
Source tape is in EBCDIC character set. Tape(s) can be prepared in most standard 7 or 9 track recording modes for one-half inch tape. Identify recording mode desired by specifying character set, track, density, and parity. Call NTIS Computer Products if you have questions.

Descriptors: *Probit analysis, *Software, *Computer programs, Regression analysis, Maximum likelihood estimation, Dosage, Magnetic tapes.
Identifiers: IBM 360 computers, IBM 370 computers, Software type = Computer program, Batch processing mode, System application = Scientific/engineering, Fortran programming language, Computer memories = 48k, Program statements = 558.

The program obtains the weighted linear regression of probits on dose or log-dose employing the maximum likelihood procedure described by D. J. Finney in 'Probit Analysis' (Cambridge University Press, 1962). The program will fit 2 to 12 parallel linear regression lines of 2 to 12 doses each giving all possible combinations of the ratios of equally effective doses, as well as points along the fitted line and their 95% fiducial limits.

PB-269 488/3CP PC **A02**/MF **A01**
Agricultural Research Service, Beltsville, Md. Data Systems Application Div.
Potency Probit Analysis, User's Guide
Richard J. Daum, Clide Givens, and Leonie Penney. Aug 69, 7p USDA/DF-77/008a
For system on magnetic tape, see PB-269 487.

Descriptors: *Regression analysis, *Computer programming, Programming manuals, Fortran, Dosage.
Identifiers: *Probit analysis, Maximum likelihood estimation, IBM 360 computers, IBM 370 computers.

The Potency Probit Analysis program obtains the weighted linear regression of probits on dose or log-dose employing the maximum likelihood procedure described by D. J. Finney in PROBIT ANALYSIS (Cambridge University Press, 1962). The program will fit 2 to 12 parallel linear regression lines of 2 to 12 doses each giving all possible combinations of the rations of equally effective doses, as well as points along the fitted line and their 95 percent fiducial limits.

PB-269 561/7CP CP **T18**
Agricultural Research Service, Beltsville, Md. Data Systems Application Div.
Incomplete Block Design, Analysis of Variance.
Software.
2 Aug 76, mag tape SW-1406, USDA/DF-77/010
Includes documentation.
Source tape is in EBCDIC character set and certain fields contain packed decimal data. Character set restricts preparation in 9 track one-half inch tape only. Identify recording mode by specifying density only. Call NTIS Computer Products if you have questions.

Descriptors: *Block design, *Software, *Analysis of variance, *Computer programs, Least-squares method, Magnetic tapes.
Identifiers: IBM 360 computers, IBM 370 computers, Software type = Computer program, Batch processing mode, System application = Scientific/engineering, Fortran G programming language, Computer memories = 48k, Program statements = 920, Other = Card reader.

The program computes an analysis of variance for partially balanced incomplete block designs with two associate classes. When certain restrictions are applied it will compute an analysis of variance for balanced incomplete block designs. Also outputted are F values, unadjusted treatment means, and both the least squares adjusted means and the weighted, recovered adjusted means.

PB-269 673/0CP PC **A03**/MF **A01**
National Oceanic and Atmospheric Administration, Boulder, Colo. Wave Propagation Lab.
Computer Programs for Maximum Entropy Spectral Analysis of Real and Complex Multichannel Time Series (with Microfilm Plots)
Technical memo.
Otto Neall Strand. Apr 77, 44p NOAA-TM-ERL-WPL-22, NOAA-77050504

Descriptors: *Time series analysis, *Computer programming, Spectrum analysis, Power spectra, Multivariate analysis, Entropy, Fortran.

Several computer programs written to implement multichannel maximum entropy spectral analysis are described. The main objective of these programs is to obtain an estimate of the multivariate power spectral density for a real or complex multichannel time series. The user is provided with enough information to enable him to implement the programs correctly.

PB-269 697/9CP PC **A06**/MF **A01**
National Oceanic and Atmospheric Administration, Washington, D.C. Environmental Data Service.
A Note on a Gamma Distribution Computer Program and Computer Produced Graphs
Technical rept.
Harold L. Crutcher, Grady F. McKay, and Danny C. Fulbright. May 77, 119p NOAA-TR-EDS-24, NOAA-77060701
Prepared by National Climatic Center, Asheville, N.C.

Descriptors: *Gamma function, *Plotting, *Computer programs, Chi square test, Degrees of freedom, Algorithms, Meteorological data.
Identifiers: Fortran 4 programming language, Parameter estimation.

The gamma distribution function may be used as a model for many sets of data. The electronic computer program for this function in the Formula Translator (Fortran) IV (1) provides the analytic solution to a set of data, (2) gives the probabilities of exceeding or not exceeding arbitrary amounts, (3) indicates the amounts exceeded or not exceeded for arbitrary probabilities, and (4) provides for computer output to microfilm, drum, or flatbed plotters. The program, in its general form, permits a maximum of 52 entries which will suffice for those dealing with weekly data through the year. In addition, such as in weekly precipitation studies, the user has the option to compute the two- and three-week duration period distributions in one pass of the data. These computations are done without program change but by appropriate changes in the control cards. This feature is not limited to the study of precipitation data nor to the time intervals used. An option permits the computation of the required probabilities and inverses when only the scale and shape parameters are given. By appropriate modification, where only one set of data is being examined, the program can accept a string of input data longer than 52.

PB-269 707/6CP CP **T08**
Bureau of the Census, Washington, D. C. Computer Methods Lab.
Cobol Census Tabulating System.
Software.
17 May 76, mag tape CEN/DF-77/002
Includes documentation.
Source tape is in EBCDIC character set. Tape(s) can be prepared in most standard 7 or 9 track recording modes for one-half inch tape. Identify recording mode desired by specifying character set, track, density, and parity. Call NTIS Computer Products if you have questions.

Descriptors: *Cocents computer program, *Software, *Demography, *Computer programs, Statistical analysis, Mathematical tables, Magnetic tapes.
Identifiers: IBM 360 computers, Operating system = OS VS, Operating system = DOS, Operating system = MCP, Software type = System, Batch processing mode, System application = Management/business, Cobol programming language, Computer memories = 16k, Program statements = 7k, Tape drives = three, Disc-drum units = one.

Cocents is a generalized computer system for the production of statistical tables. Although originally created for use in Census applications, it can satisfy the requirements of generating statistical tables for a host of managerial and business applications. The Cocents system requires no data processing background for preparing the necessary parameter cards to generate the desired tables; one can easily teach their existing staff to use the system. The system requires a Cobol compiler, card reader, line printer, and three tape drives or one random access storage device.

PB-269 708/4CP PC **A14**/MF **A01**
Bureau of the Census, Washington, D.C. Computer Methods Lab.
COCENTS, Cobol Census Tabulating System Reference Manual
Mar 76, 316p* CEN/DF-77/002a
For system on magnetic tape, see PB-269 707.

Descriptors: *Demography, *Computer programming, Programming manuals, Statistical analysis, Mathematical tables, Cobol.
Identifiers: *Cocents computer program, IBM 360 computers.

This is the Reference Manual for the Cobol Census Tabulating System. Cocents is a generalized computer system for the production of statistical tables. Although, originally created for use in Census applications, it can satisfy the requirements of generating statistical tables for a host of managerial and business applications. The Cocents system requires no data processing background for preparing the necessary parameter cards to generate the desired tables; one can easily teach their existing staff to use the system.

PB-270 454/2CP PC **A10**/MF **A01**
Illinois Univ. at Urbana-Champaign. Water Resources Center.
Optimal Operation of Flood Control Systems. Volume II
Final rept.
Ching-Ju Feng, and Thomas L. Morin. Mar 77, 202p UILU-WRC-77-0122, OWRT-A-079-ILL(2)
Contract DI-14-31-0001-6014
Prepared by Northwestern Univ., Evanston, Ill. Dept. of Industrial Engineering and Management Sciences.

Descriptors: *Flood control, *Reservoirs, *Dynamic programming, Stochastic processes, Mathematical models, River basins, Illinois, Computer programs, Computation.
Identifiers: Markov renewal processes.

The management and control of multiple-reservoir flood control systems is studied. The objective is to devise operating policies which minimize flood damages as determined by the flood peaks. Methodologies are presented that employ dynamic programming and stochastic dynamic programming for the optimal operation of multiple-reservoir flood control systems with deterministic and stochastic inflows, respectively. The methodologies are applied to a number of real-world problems involving river basins in Illinois and elsewhere. The effects of parametrically varying a number of the input parameters are considered. A Markov renewal flood synthesis model and a methodology for determining the optimal capacity of a new flood control reservoir are also presented.

PB-270 674/5CP PC **A07**/MF **A01**
Control Analysis Corp., Palo Alto, Calif.
Computer Code for Transportation Network Design and Analysis
Interim rept. Jan-Oct 76
R. P. Harvey, and D. W. Robinson. May 77, 126p DOT-TSC-OST-77-39
Contract DOT-TSC-1059
See also report dated Oct 76, PB-261 340.

Descriptors: *Transportation models, *Decomposition method, *Computer programming, Allocations, Network flows, Network analysis theory, Algorithms.
Identifiers: *Catnap computer program.

This document describes the results of research into the application of the mathematical programming technique of decomposition to practical transportation network problems. A computer code called Catnap (for Control Analysis Transportation Network Analysis Program) has been developed in the course of this study; this code has the capability to solve the following problems: (1) The traffic assignment problem with fixed demands; (2) The transportation network design problem with or without a budget constraint; (3) The optimal staging problem for transportation network investments over a fixed time horizon. In this report the authors describe the basic structure and algorithms employed in Catnap and give actual numerical results obtained in some representative sample problems. These results indicated that Catnap is an improvement over existing transportation network codes, particularly for solving the network design problem.

PB-270 855/0CP PC **A09**/MF **A01**
National Bureau of Standards, Washington, D.C. Inst. for Basic Standards.
OMNITAB II User's Reference Manual 1977 Supplement
Final rept.
David Hogben, and Sally T. Peavy. Jul 77, 177p*
Rept no. NBSIR-77-1276
Sponsored in part by National Highway Traffic Safety Administration, Washington, D.C. See also COM-71-50609.

Descriptors: *Computer programming, *Statistical analysis, *Numerical analysis, Plotting, Curve fitting, Regression analysis, Computation, Programming manuals.
Identifiers: *Omnitab 2 system, *Omnitab 1977, Calcomp plotters.

The supplement describes all the additions and improvements made to the Omnitab 2 computing system at NBS since 1970. Omnitab 1977, as Omnitab 2 is now known, is fully interactive. Major new capabilities now exist in the following areas: Use of labels, table making, plotting, numerical analysis, editing of data, stem-and-leaf displays, selection of variables in linear regression and probability plotting. The supplement is an interim document for use until Omnitab 1977 is released and new documentation prepared.

PB-272 130/6CP Mag Tape $1750.00
National Institutes of Health, Bethesda, Md. Lab. of Statistical and Mathematical Methodology.
Mlab - an Online Modeling System.
Software.
1972, mag tape NIH/DF-77/004
Includes documentation.(CP T00)
Source tape is in ASCII character set. Character set restricts preparation to 9 track one-half inch tape only. Identify recording mode by specifying density only. Call NTIS Computer Products, if you have questions.

Descriptors: *Computer programs, *Curve fitting, *Software, Online interactive systems, Tenex system, Mathematical models, Computations, Differential equations, Matrices(Mathematics).
Identifiers: Decsystem 10 computers, Decsystem 20 computers, Operating system = PDP, Software type = System, Interactive processing mode, System application = Scientific/engineering, Mlab

programming language, Computer memories = 80k, Program statements = 75k.

Mlab is an interactive system for mathematical modeling. The heart of the system is a nonlinear curve-fitting procedure. Facilities for differential equation models, symbolic differentiation, root-finding, graphic display and plotting, function evaluation including sums and integrals, matrix calculation, and saving and restoring data between sessions are included.

PB-272 131/4CP PC A15/MF A01
National Institutes of Health, Bethesda, Md. Lab. of Statistical and Mathematical Methodology.
MLAB - An Online Modeling Laboratory. Seventh Edition
Gary D. Knott, and Doug Reece. Jul 77, 333p* NIH/DF-77/004a
For system on magnetic tape see PB-272 130.

Descriptors: *Curve fitting, *Mathematical models, *Computer programming, Computation, Differential equations, Matrices(Mathematics), Numerical integration.
Identifiers: *MLAB system, Tenex system, Decsystem 10 computers, Decsystem 20 computers.

MLAB is an interactive system for mathematical modeling. The heart of the system is a non-linear curve-fitting procedure. Facilities for differential equation models, symbolic differentiation, root-finding, graphic display and plotting, function evaluation including sums and integrals, matrix calculation, and saving and restoring data between sessions are included.

PB-272 173/6CP PC A05/MF A01
Clemson Univ., S.C. Dept. of Mathematical Sciences.
Regional Shrimp Catch and Effort Statistical Information System. Activity I. Research and Analysis
Final rept.
Robert F. Ling, Fred W. Morgan, and Herman F. Senter. Dec 76, 100p NOAA-77080309
Sponsored in part by South Carolina Wildlife and Marine Resources Dept., Charleston. Marine Resources Center.

Descriptors: *Shrimps, *Sampling, North Atlantic Ocean, North Carolina, South Carolina, Computerized simulation, Computer programs, Prices, Costs, Tables(Data).
Identifiers: *Shrimp catch, Parameter estimation, Data management systems, Commercial fishing, SHREDIT computer program.

The analyses of this study show quite clearly that among the eight feasible sampling strategies considered for estimating the numerous catch and effort parameters of interest, the strategy which provides the best estimates over-all, as measured by mean square error, is the strategy 'X% of the dealers stratified by region, 100% of their trips', denoted simply DBR (dealer by region). Moreover, for each of three data collection methods considered, the estimated implementation cost of a twenty-five per cent sample using DBR was no greater than that of other strategies and was considerably less than most. Thus the sampling strategy DBR is optimal both in terms of mean square error of estimates and implementation costs.

PB-272 942/4CP PC A11/MF A01
Iowa Inst. of Hydraulic Research, Iowa City.
Inter-District Water Allocations via Linear Programming and Linear Programming Decomposition
Masakazu Seki, and Thomas E. Croley, II. Sep 77, 228p Rept no. IIHR-207
Sponsored in part by Ministry of Construction, Tokyo (Japan).

Descriptors: *Water resources, *Allocation models, *Linear programming, Decomposition method, Costs, River basins, Prices, Economic analysis, Computer programs, Optimization, Japan.
Identifiers: Yamato River Basin, Nara(Japan).

An interdistrict water flow table is developed to account for all water flows within a river basin and to identify all water-related variables for analysis. Linear models are identified for hydrologic variables, environmental variables, human factor variables, water use and water demands. Objective formulations of economic, political, environmental and population are made and the constraint formulations of these objectives are also made. Several models of water allocations are thus available with the main objective expressed in the objective function with all others in constraint form. The equations of continuity and motion are also encapsulated in the model. A case study to the Yamato river basin in Nara, Japan is made and both linear programming and linear programming decomposition are applied as tools in the minimization of total cost. The final optimum allocation differs little from the existing allocation, indicating the present system is near-optimum with respect to total cost. The decomposition principal allocation allows for useful insight into decentralized decision making although it proved to be a poorer tool for analysis in the example. The linear programming formulation and the computer program for analysis with the decomposition principle are presented.

PB-276 335/7CP CP T09
Forest Service, Washington, D.C. Computer Systems Applications.
Statistics for Unweighted Data.
Software.
29 Jul 77, mag tape SW-98881058, USDA/DF-78/010
All prices cited are for the North American Continent ONLY, all others write for quote. Source tape is in EBCDIC character set. Tape(s) can be prepared in most standard 7 or 9 track recording modes for one-half inch tape. Identify recording mode desired by specifying character set, track, density, and parity. Call NTIS Computer Products if you have questions.

Descriptors: *Statistical analysis, *Computer programs, *Software, Measure theory.
Identifiers: Univac 1100/42 computers, Operating system = Exec 8 vers 32/R/2, Software type = Computer program, Combination processing mode, System application = Scientific/engineering, Basic programming language, Program statements = 200, Computer memories = 18k, Disc-drum units = one, Computers terminals = one.

This program computes 31 statistical measures of a string of unweighted numbers. The formulas were taken from the National Bureau of Standards Handbook 101. The data string is to be terminated with a zero, therefore no data point can be exactly zero as this would end the reading of data. The program counts the number of data points entered.

PB-276 459/5CP CP T09
Forest Service, Washington, D.C. Computer Systems Applications.
Equate Linear Regression.
Software.
29 Jul 77, mag tape SW-70001013, USDA/DF-78/011
All prices cited are for the North American Continent ONLY, all others write for quote. Source tape is in EBCDIC character set. Tape(s) can be prepared in most standard 7 or 9 track recording modes for one-half inch tape. Identify recording mode desired by specifying character set, track, density, and parity. Call NTIS Computer Products if you have questions.

Descriptors: *Regression analysis, *Computer programs, *Software, Curve fitting, Least squares method.
Identifiers: Univac 1100/42 computers, Operating system = Exec 8 vers 32/R/2, Software type = Computer program, Combination processing mode, System application = Scientific/engineering, Basic programming language, Program statements = 108, Computer memories = 18k.

This program produces an equation that best fits input points described by X and Y coordinates. This fit is made in the least-squares sense.

PB-276 570/9CP CP T09
Forest Service, Washington, D.C. Computer Systems Applications.
Statistical Measures
Software.
29 Jul 77, mag tape SW-98881055, USDA/DF-78/006
All prices cited are for the North American Continent ONLY, all others write for quote. (1;EBCDIC).

Descriptors: *Statistical analysis, *Computer programs, *Software, Frequency distribution, Mean, Standard deviation.
Identifiers: Univac 1100/42 computers, Operating system = Exec 8 vers 32/R/2, Software type = Computer program, Combination processing mode, System application = Scientific/engineering, Basic programming language, Program statements = 193, Computer memories = 32k, Disc-drum units = one, Computers terminals = one.

This program performs a statistical analysis on data for one variable. It computes 34 different measures for an array of weighted (as with frequencies) or unweighted values of the variable. It also gives a 10-class frequency distribution summary, and a recapitulation of the input data in terms of deviations from the mean and as an ordered array.

PB-276 571/7CP CP T09
Forest Service, Washington, D.C. Computer Systems Applications.
Multiple Linear Regression
Software.
29 Jul 77, mag tape SW-98881031, USDA/DF-78/007
All prices cited are for the North American Continent ONLY, all others write for quote. (1;EBCDIC).

Descriptors: *Regression analysis, *Computer programs, *Software.
Identifiers: Univac 1100/42 computers, Operating system = Exec 8 vers 32/R/2, Software type = Computer program, Combination processing mode, System application = Scientific/engineering, Fortran programming language, Program statements = 360, Computer memories = 30k, Tape drives = one, Disc-drum units = one.

This program fits the model Y-M(Y)=(X(1)-M(X(1)))*B(1)+(X(2)-M(X(2)))*B(2)+...+(X(N)-M(X(N)*B(N), to a series of N discrete observations where: X(1),X(2),X(3),...,X(N) represent the independent variables; Y represents an observed data point; M(X(1)),M(X(2)),M(X(3)),...,(M(X(N)) represent the mean value of the independent variables; and (M(Y) represents the mean value of the observed data points.

PB-276 572/5CP CP T09
Forest Service, Washington, D.C. Computer Systems Applications.
Generalized Analysis of Variance
Software.
29 Jul 77, mag tape SW-98881075, USDA/DF-78/004
All prices cited are for the North American Continent ONLY, all others write for quote. (1;EBCDIC).

Descriptors: *Analysis of variance, *Computer programs, *Experimental design, *Software, Block design.
Identifiers: Univac 1100/42 computers, Operating system = Exec 8 vers 32/R/2, Software type = Computer program, Combination processing mode, System application = Scientific/engineering, Basic programming language, Program statements = 193, Computer memories = 18k, Disc-drum units = one, Computers terminals = one.

This program can be used to partition sums of squares for many types of complete block experimental designs. Sources of variation may be either (vested) or (crossed) so long as equal numbers exist in the subclasses. The user defines the design by the sources of variation. Permissible designs include the completely random, randomized complete block, N-factorial, split plots, completely nested, and various confounded and mixed desgn.

PB-276 573/3CP CP **T09**
Forest Service, Washington, D.C. Computer Systems Applications.
Compute Roots and Relative Maximums and Minimums
Software.
29 Jul 77, mag tape SW-98881083, USDA/DF-78/012
All prices cited are for the North American Continent ONLY, all others write for quote. (1;EBCDIC).

Descriptors: *Roots of equations, *Computer programs, *Software, Computation.
Identifiers: Univac 1100/42 computers, Operating system = Exec 8 vers 32/R/2, Software type = Computer program, Interactive processing mode, System application = Scientific/engineering, Basic programming language, Program statements = 124, Computer memories = 20k, Disc-drum units = one, Computers terminals = one.

This program will locate the roots and relative maximums and minimums for any function of X by checking a finite number of points, equally spaced with a given interval, for a change in sign of f(X) or its derivative.

PB-276 575/8CP CP **T09**
Forest Service, Washington, D.C. Computer Systems Applications.
Linear Programming Computation
Software.
29 Jul 77, mag tape SW-98882000, USDA/DF-78/003
All prices cited are for the North American Continent ONLY, all others write for quote. (1;EBCDIC).

Descriptors: *Linear programming, *Computer programs, *Software, Constraints, Optimization.
Identifiers: Univac 1100/42 computers, Operating system = Exec 8 vers 32/R/2, Software type = Computer program, Interactive processing mode, System application = Scientific/engineering, Fortran programming language, Program statements = 238, Computer memories = 30k, Disc-drum units = one, Computers terminals = one.

This program computes the optimum solutions for linear programming problems. A linear objective function is maximized (or minimized) subject to a set of linear constraints.

PB-276 576/6CP CP **T09**
Forest Service, Washington, D.C. Computer Systems Applications.
Least Squares Orthogonal Poly Fit
Software.
29 Jul 77, mag tape SW-98881040, USDA/DF-78/005
All prices cited are for the North American Continent ONLY, all others write for quote. (1;EBCDIC).

Descriptors: *Bivariate analysis, *Least squares method, *Computer programs, *Software, Polynomials, Curve fitting.
Identifiers: Univac 1100/42 computers, Operating system = Exec 8 vers 32/R/2, Software type = Computer program, Combination processing mode, System application = Scientific/engineering, Basic programming language, Program statements = 185, Computer memories = 12k, Disc-drum units = one, Computers terminals = one.

This program fits least-square polynomials to bivariate data, using an orthogonal polynomial method. Limits are 11th degree fit and a maximum of 100 data points. Program allows user to specify the lowest degree polynomial to be fit, and then fits the polynomials in order of ascending degree. At each stage, the index of determination is printed, and the user has the choice of going to the next higher degree fit, seeing either of two summaries of fit at that stage, or of stopping the program. Note that this program may produce invalid results beyond the fifth degree fit.

PB-277 307/5CP Not available NTIS
National Bureau of Standards, Washington, D.C.
DATAPAC: A Data Analysis Package
Final rept.
James J. Filliben. 1976, 6p

Pub. in Proceedings of Interface Symposium on Computer Science and Statistics (9th), Boston, Mass., April 1-2, 1976, p212-217 1976.

Descriptors: *Subroutines, *Statistical analysis, Distribution functions, Probability density functions, Time series analysis, Regression analysis, Random numbers, Fortran.
Identifiers: DATAPAC subroutines, Random number generators, Computer program portability.

DATAPAC is a homogeneous and systematic set of Fortran subroutines for statistical data analysis. DATAPAC subroutines are portable (ANSI Fortran) and stand-alone (self-contained) with simple, systematic, and consistent subroutine names, simple argument structure, and modularized internal coding. The 168 DATAPAC subroutines are grouped into 14 categories: cumulative distribution functions, probability density functions, percent point functions, sparsity functions, random number generators, probability plots, individual statistics, general analyses, time series analyses, polynomial regression, printer plots, terminal plots, I/O, and data manipulation. The DATAPAC package is unique in the completeness of its cdf/pdf/ppf/sf categories, its probability plot category (18 distributions), and its tail length analyses (3 distributions).

PB-279 859/3CP PC **A04**/MF **A01**
Mathematics and Computation Lab. (EDM), Washington, D.C.
Maps: A Matrix Arithmetic Programming System
Final rept.
Mar 78, 71p Rept no. GSA/FPA/MCL-TM-262

Descriptors: *Programming languages, *Matrices(Mathematics), *Vectors(Mathematics), Macroprogramming, Computer programs, Programming manuals.
Identifiers: *MAPS programming languages, MAPS system, Data manipulation.

The Matrix Arithmetic Programming System is a programming language developed to give users the capability to manipulate vectors and matrices. It includes an interface to the Economic Computer Language common data bank system (ECL), developed by the Applied Economics Division, and provides limited tape input and output capabilities. This manual describes the organization and design of MAPS, how to use MAPS, including a directory of MAPS instructions, and presents several sample MAPS runs.

PB-280 191/8CP PC **A03**/MF **A01**
California Univ., Los Angeles. Dept. of Chemical, Nuclear, and Thermal Engineering.
Probability Intervals for the Reliability of Complex Systems Using Monte Carlo Simulation
Yum Tong Lee, and Steven L. Salem. Dec 77, 45p Rept no. UCLA-ENG-7758
Grant NSF-OEP75-20318

Descriptors: *Reliability, *Probability theory, *Fault tree analysis, Nuclear power plants, Risk, Monte Carlo method, Uncertainty, Computer programs, Fortran, Pressurized water reactors.
Identifiers: LIMITS computer program, Loss of coolant.

A method of assessing the uncertainty in the TOP event probability of a fault tree by a Monte Carlo simulation is presented in this report. This approach is used to produce an empirical Bayes estimate of the probability intervals of TOP event unreliability. The Monte Carlo simulation used here proceeds by propagating basic event probabilities, chosen randomly from input probability distributions through the tree, producing an empirical TOP event probability distribution (with associated confidence limits) after combining the results of many trials. This report discusses the basic principles of this Monte Carlo approach, and presents a new computer code, LIMITS, which is then used in several examples, and compared with the earlier SAMPLE code developed for the Reactor Safety Study. The results show that the LIMITS code is significantly faster due to an optimized sorting routing and that, in general, an even slightly faster code would be possible by the use of special random-number generators. Finally, sample input and output, and a listing of the program are provided for the reader who might wish to use the LIMITS code.

PB-280 370/8CP PC **A20**/MF **A01**
National Bureau of Standards, Washington, D.C.
Computer Science and Statistics: Annual Symposium on the Interface. Proceedings of the Annual Symposium (10th) Held at the National Bureau of Standards, Gaithersburg, Maryland, April 14-15, 1977
Final rept.
David Hogben, and Dennis W. Fife. Mar 78, 468p* Rept no. NBS-SPECIAL PUB 503
Grant NSF-MCS77-04441

Descriptors: *Computer programming, *Statistical analysis, *Meetings, Computer graphics, Minicomputers, Computerized simulation, Analysis of variance, Regression analysis, Time series analysis, Numerical analysis, Linear programming, Approximation.
Identifiers: Interactive graphics, Computer software, Data files, Robust procedures, Integer programming.

The Proceedings of Computer Science and Statistics: Tenth Annual Symposium on the Interface contains 36 invited and 36 contributed poster session papers. The invited papers were presented in six workshops on Evaluation of Statistical Software, Nonlinear Models, Graphics, Large Data Files, Numerical Analysis in Statistics, and Maintenance and Distribution of Statistical Software. The Evaluation of Statistical Software Workshop was divided into two sessions on Statistical Program Packages for Small Computers and Computing Approaches to the Analysis of Variance for Unbalanced Data.

PB-282 525/5CP PC **A04**/MF **A01**
Pittsburgh Univ., Pa. Graduate School of Business.
User's Manual, QRMNEW
Interim working paper, 1 Apr-1 Aug 76
Jerrold H. May. Feb 78, 75p Rept nos. WP-168, UPITT/GSB-78/01
Grant AFOSR-74-2695, NSF-ENG75-09887

Descriptors: *Nonlinear programming, *Computer programs, Matrices(Mathematics), Partial differential equations, Computation, Iteration, Algorithms, Fortran.
Identifiers: QRMNEW subroutines, Fortran 4 programming language, DEC-1077 computers, IBM-360/50 computers, Constrained minimization.

QRMNEW is the implementation of the algorithm described in Working Paper Number 228, 'Solving Nonlinear Programs without using Analytic Derivatives,' which is a local variations-modified Newton method for minimizing linearly constrained and unconstrained nonlinear programming problems. A mathematical summary of the algorithm is included. QRMNEW is a set of subroutines. The user must supply a subroutine which evaluates the objective function, constraint data, several parameters, and a main program which calls the optimization package. The user program requirements and data deck setup is described, and detailed results for a test problem are included. Annotated output for the test problems is shown, covering all possible messages generated by the program. Computational results for an extensive set of test problems follow. An appendix contains a flow chart for the subroutines, a dictionary of the program variables, and a listing of the program. (Portions of this document are not fully legible)

PB-289 721/3CP PC **A06**/MF **A01**
National Climatic Center, Asheville, NC.
Gamma Distribution Bias and Confidence Limits
Technical rept.
Harold L. Crutcher, and Raymond L. Joiner. Sep 78, 112p NOAA/TR/EDIS-30, NOAA-78112404

Descriptors: *Bias, *Confidence limits, Statistical distributions, Statistical dispersion, Accuracy, Tables(Data).
Identifiers: *Gamma density functions, GAMTST computer program.

The generalized gamma distribution has three parameters: the origin, the scale, and the shape. As a model, it serves to approximate distributions in many disciplines. To be an accurate model, the model should contain no bias or should contain as little bias as possible. To be a more useful model, the model should show the confidence in the fit it provides. Rarely is the bias removed in actual practice; up to the present time, there has been no way to place confidence bands on the cumulative distribution or line of best fit. Procedures have been available to compute confidence intervals for the parameter estimates themselves. This report extends the available procedures to remove bias from sample sizes 10 or more to sample sizes 2 or more. This report develops procedures to compute confidence intervals for selected percentile quantiles which permit the plotting of data against the background of the model with its line of best fit and confidence bands. (Portions of this document are not fully legible)

PER-19 MF **A01**
Atomic Energy Board, Pelindaba, Pretoria (South Africa).
ICCG Method for the Iterative Solution of Large Sparse Linear Systems
J. D. Neethling. Sep 77, 15p
Available in microfiche only. U.S. Sales Only.

Descriptors: *Matrices, Computer codes, Differential equations, Equations, Iterative methods, Numerical solution, Series expansion, Vectors.
Identifiers: ERDA/990200, South Africa, Conjugate gradient method.

A modified version of the conjugate gradient method (CG) for the iterative solution of large sparse linear systems is described. The method is first applied to symmetric positive definite matrices. Preceding the application of CG by an incomplete Choleski decomposition which is computationally inexpensive, has the effect of improving the convergence of CG considerably thereby rendering the algorithm computationally attractive. An extention to non-symmetric matrices as well as computer routines for the symmetric case are given. (Atomindex citation 08:344340)

PNL-2409 PC **A04**/MF **A01**
Battelle Pacific Northwest Labs., Richland, Wash.
COMP: A BASIC Language Nonlinear Least-Squares Curve Fitting Program
J. M. Thomas, M. I. Cochran, C. R. Watson, and L. L. Eberhardt. Nov 77, 54p
Contract EY-76-C-06-1830

Descriptors: *Computer codes, *Least square fit, C codes, Errors, Mathematical models, Statistics.
Identifiers: ERDA/990200, COMP computer program, BASIC programming language, Parameter estimation, Nonlinear systems, Curve fitting.

COMP is an interactive nonlinear least squares routine written in BASIC language and used to obtain estimates of parameters in nonlinear functions and to approximate their associated statistical errors. The program uses the linearizing (or Taylor Series) expansion of partial derivatives outlined in Draper and Smith, (1966, pp. 267 to 270). Therefore, partial derivatives must be supplied (as well as the function) by the user for any new models not currently contained in the programs. When a linearizing method is used to estimate parameters in a nonlinear model, all the usual procedures of linear regression theory can be applied. However, the results so obtained are only valid insofar as the linearized form approximates the true model. All of the statistics computed by COMP should be viewed with this restriction in mind. The output of COMP includes the variance-covariance matrix, t-tests for parameters, Von Neumann's ratio, observed, predicted and residual values, the error mean square, and an optional procedure to evaluate heteroscedasticity. (ERA citation 03:020808)

PPGM-L97-76 PC **A03**/MF **A01**
Gamma Research Centre, Yogyakarta (Indonesia).
Numerical Solution of Differential Equation with Runge-Kutta Method
1976, 40p
U.S. Sales Only.

Descriptors: *Computer codes, *Differential equations, *Runge-Kutta method, Algorithms, Fortran, HP computers, Numerical solution, Programming.
Identifiers: ERDA/990200, Indonesia, Numerical integration.

The Runge-Kutta method for solving a linear differential equation with appropriate programming using the Hewlett Packard-65 Calculator is discussed. A subroutine program written in the Fortran language, which may be used when a computer is available, is given. (Atomindex citation 09:366216)

PPPL-1408 PC **A02**/MF **A01**
Princeton Univ., N.J. Plasma Physics Lab.
WKB: An Interactive Code for Solving Differential Equations Using Phase Integral Methods
R. B. White. Jan 78, 23p
Contract EY-76-C-02-3073

Descriptors: *Computer codes, *Differential equations, Plasma, Potential energy, W codes, Wkb approximation.
Identifiers: ERDA/700105, Programming manuals.

A small code for the analysis of ordinary differential equations interactively through the use of Phase Integral Methods (WKB) has been written for use on the DEC 10. This note is a descriptive manual for those interested in using the code. (ERA citation 03:020516)

PPPL-1435 PC **A03**/MF **A01**
Princeton Univ., N.J. Plasma Physics Lab.
Program Generator for the Incomplete Cholesky Conjugate Gradient (ICCG) Method
G. Kuo-Petravic, and M. Petravic. Apr 78, 32p
Contract EY-76-C-02-3073

Descriptors: *Computer codes, *Differential equations, Analytical solution, G codes, Plasma, S codes.
Identifiers: ERDA/700105, Conjugate gradient method.

The Incomplete Cholesky Conjugate Gradient (ICCG) method has been found very effective for the solution of sparse systems of linear equations. Its implementation on a computer, however, requires a considerable amount of careful coding to achieve good machine efficiency. Furthermore, the resulting code is necessarily inflexible and cannot be easily adapted to different problems. We present in this paper a code generator GENIC which, given a small amount of information concerning the sparsity pattern and size of the system of equations, generates a solver package. This package, called SOLIC, is tailor made for a particular problem and can be easily incorporated into any user program. (ERA citation 03:043899)

RCN-169 PC **A02**/MF **A01**
Reactor Centrum Nederland, Petten.
Simple Method for the Construction of Splines with Piecewise Pre-Described Surfaces over Given Intervals
H. A. Van Der Vorst. Feb 72, 19p
U. S. Sales only

Descriptors: *Algorithms, *Computer programs, *Spline functions.

For abstract, see NSA 26 20, number 50023.

RE-A-78-049 PC **A03**/MF **A01**
EG and G Idaho, Inc., Idaho Falls.
User's Guide to ANYOLS: a Regression Program Allowing Many Ways to Select a Model
C. L. Atwood. Mar 78, 33p
Contract EY-76-C-07-1570

Descriptors: *Computer codes, A codes, Fortran, Least square fit.
Identifiers: ERDA/990200, ANYOLS computer program.

Program package ANYOLS allows the user to fit one or more ordinary least squares regression models in a stepwise or predetermined way. Possible stepwise selection criteria are: F, s exp 2 , MSE (from C/sub p/) and PRESS. Possible predetermined ways are: to get all possible regressions and to get all possible regressions which include the first variable. Other ways may be specified by a user-written subroutine. User control of input, variable selection criteria and output is through short user-written FORTRAN subroutines. (ERA citation 03:058091)

RL-75-116 PC **A02**/MF **A01**
Science Research Council, Chilton (UK). Rutherford Lab.
Intersection of Two Quadrilaterals in a Plane.
D. Bryan, and A. G. Armstrong. Jul 75, 10p
U.S. Sales Only.

Descriptors: *Computer codes, *M codes, *Geometry, Computer codes, Fortran, Two-dimensional calculations.
Identifiers: ERDA/990200, Great Britain.

The intersection of two quadrilaterals lying in a plane uses the concept that any side of one quadrilateral cuts the plane into two halves, the open half plane and the closed half plane; then, by checking the nodes of the other quadrilateral and vice versa, the intersection can be determined.

RT/EDP-(75)3 PC **A03**/MF **A01**
Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
Interactive Polyalgorithm
L. Biasini, C. Fucci, and V. Gardelli. Jul 75, 35p
U.S. Sales Only. In Italian.

Descriptors: *Algorithms, *Computer codes, *Differential equations, *Numerical analysis, Automation, Numerical solution, P codes.
Identifiers: ERDA/990200, Italy.

This paper presents a summary of the experiences and viewpoints in the construction of interactive polyalgorithms for automatic numerical analysis. In addition, a particular structure of a polyalgorithm on differential equations is illustrated. Finally, a sample problem is worked out by computer. (2 figures). (ERA citation 01:022355)

RT/FIMA-(75)1 PC **A02**/MF **A01**
Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
Subroutine for Bidimensional Interpolation with Bicubic Spline Functions.
G. Cenacchi, and P. Mengoli. Mar 75, 25p
In Italian. U.S. Sales Only.

Descriptors: *Interpolation, Computer codes, *Computer codes, *S codes, Fortran, Functions.
Identifiers: ERDA/990200, *Spline functions.

A subroutine (written in FORTRAN IV) is presented for the bidimensional interpolation of a function given at the nodes of a rectangular mesh. The method is based on bicubic spline functions.

SAND-74-0057 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Local Error Control in Codes for Ordinary Differential Equations.
L. F. Shampine. Jul 74, 32p
Contract AT(29-1)-789

Descriptors: *Differential equations, *Errors, Computer codes, Computers, Control, Extrapolation, Numerical solution.

For abstract, see NSA 30 08, number 23324.

SAND-74-0380 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Colode: A Collocation Subroutine for Ordinary Differential Equations.
B. L. Hulme, and S. L. Daniel. Dec 74, 32p
Contract AT(29-1)-789

Descriptors: *Computer codes, *C codes, *Differential equations, *Numerical solution.

For abstract, see NSA 31 08, number 21911.

SAND-74-0381 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Using Stfode/Colode to Solve Stiff Ordinary Differential Equations.
B. L. Hulme, and S. L. Daniel. Dec 74, 15p
Contract AT(29-1)-789

Descriptors: *Computer codes, *C codes, *Differential equations, *Numerical solution, S codes.

For abstract, see NSA 31 08, number 21912.

SAND-74-5281 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Systematized Collection of Codes for Solving Two-Point Boundary-Value Problems.
M. R. Scott, and H. A. Watts. 1975, 41p Rept no. CONF-750902-7

Descriptors: *Boundary conditions, *Computer codes, Finite difference method, I codes, Numerical solution, S codes.
Identifiers: ERDA/990200, *Two point boundary value problems.

A collection of codes for the numerical solution of boundary-value problems is described; insofar as possible, the arguments of call lists are identical in name and usage. The codes are planned for routine solutions by such means as the finite difference method or the multiple shooting method with variable step integrator. The methods used by the presently available codes are discussed, and the performance of SUPORT, INVIMB, SUPORQ, and SHOOT1 are shown for several sample problems. Code listings are not provided.

SAND-74-8222 PC **A04**/MF **A01**
Sandia Labs., Livermore, Calif.
User'S Guide to the Sandia Mathematical Program Library at Livermore.
R. E. Huddleston, and T. H. Jefferson. Sep 74, 75p
Contract AT(29-1)-789

Descriptors: *Computer codes, *Manuals, *Mathematics, Manuals, Sandia laboratories.

For abstract, see NSA 31 01, number 02632.

SAND-75-0147 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Cdc 6600 Subroutines for Bessel Functions J nu (X), X Greater Than or Equal to O, nu Greater Than or Equal to O and Airy Functions Ai(X), Ai'(X), - Infinity < X < Infinity
D. E. Amos, S. L. Daniel, and M. K. Weston. Sep 76, 38p
Contract EY-76-C-04-0789

Descriptors: *Airy functions, *Bessel functions, *Computer codes, A codes, Asymptotic solutions, B codes, Cdc computers, D codes, Fortran, Power series, Series expansion.
Identifiers: ERDA/990200, CDC 6600 computers, Computation.

Subroutine BESJ implements the power series, the asymptotic expansion for x implies infinity, and the uniform asymptotic expansion for nu implies infinity for J/sub nu /(x). In the region x > nu forward recursion is stable, and values from the asymptotic expansion for x implies infinity with small nu are used to start the recursion for x > 20. Except for x < exp 1 / sub 2 , where the series is used, the Miller backward recursive algorithm, normalized by the power series for the expansion for nu implies infinity, is utilized to compute sequences of Bessel functions and cover other parts of the (nu ,x) plane where no normalization expression is available. The normalization is always computed first with the leading term tested for underflow before any extensive computation is done. Chebyshev expansions on appropriate intervals are used in functions AIRY and DAIRY for the Airy functions Ai(x) and Ai'(x), respectively. A scaling option to remove the exponential decay for x > 0 is also available. 2 figures. (ERA citation 02:028240)

SAND-75-0148 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Cdc 6600 Subroutines for Bessel Functions.
D. E. Amos, and S. L. Daniel. Sep 75, 7p
Contract AT(29-1)-789

Descriptors: *Computer codes, *B codes, *Bessel functions, *Computer calculations, Cdc computers, Fortran.
Identifiers: ERDA/990200, CDC-6600 computers.

Rational approximations on suitable intervals are implemented to compute J sub 0 (x) or J sub 1 (x) in subroutine BESJ01. Similar approximations are implemented for Y sub 0 (x) or Y sub 1 (x) on x > 0 in subroutine BESY01. J sub 0 (x) and J sub 1 (x) for x > 0 are also computed and returned from BESY01.

SAND-75-0149 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Cdc 6600 Subroutines for Bessel Functions.
D. E. Amos, and S. L. Daniel. Sep 75, 9p
Contract AT(29-1)-789

Descriptors: *Bessel functions, *Computer calculations, *Computer codes, *B codes, Cdc computers, Fortran.
Identifiers: ERDA/990200, CDC-6600 computers.

Chebyshev approximations on suitable intervals are implemented in subroutine BESI01 to compute I sub 0 (x) or I sub 1 (x). An option for scaling by exp(-absolute value of x) is also provided. Similar approximations with an option for exp(x) scaling are implemented in subroutine BESK01 for K sub 0 (x) and K sub 1 (x) on x > 0.

SAND-75-0150 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Cdc 6600 Subroutines for Bessel Functions and Airy Functions.
D. E. Amos, and S. Daniel. Sep 75, 11p
Contract AT(29-1)-789

Descriptors: *Computer codes, *B codes, *Bessel functions, *Computer calculations, *Airy functions, Computer calculations, Cdc computers, D codes, Recursion relations.
Identifiers: ERDA/990200, CDC-6600 computers, BESYN subroutine.

Subroutine BESYN implements the three-term recursion relation for Y/sub nu /(x) in forward recursion starting with Bessel function values for two consecutive integers. If nu is less than 100, Y sub 0 (x) and Y sub 1 (x) are generated for the first members of the recursion relation. If nu is greater than or equal to 100, the uniform asymptotic expansion is used. The subroutine is also designed for sequences of integer-order functions. Except for small orders, the leading term of the asymptotic expansion can be used to determine whether Y/ sub nu /(x) is within the exponent range of the machine. If it is, then BESYN computes the proper value with errors on the order of 10 exp -12 , the scale being absolute in the oscillation region and relative in the growth region near the origin. Chebyshev expansions on appropriate intervals are used in functions BAIRY and DBAIRY for the Airy functions Bi(x) and Bi'(x), respectively. A scaling option to remove the exponential growth for x > 0 is also available.

SAND-75-0151 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Cdc 6600 Subroutine for Bessel Functions.
D. E. Amos, and S. L. Saniel. Sep 75, 8p

Descriptors: *Computer codes, *B codes, *Recursion relations, *Computer calculations, Cdc computers.
Identifiers: ERDA/990200, *Bessel functions, CDC-6600 computers.

Subroutine BESKN implements the three-term recursion relation for K/sub nu /(x) in forward recursion starting with Bessel function values for two consecutive integers. If nu is less than 35, K sub 0 (x) and K sub 1 (x) are generated for the first members of the recursion relation. If nu is greater than or equal to 35, the uniform asymptotic expansion is used. The subroutine is also designed for scaled functions, exp(x)K/sub nu /(x), as well as sequences of scaled or unscaled functions. Except for small orders, the leading term of the asymptotic expansion can be used to determine whether K/ sub nu /(x) is within the exponent range of the machine. If it is, then BESKN computes the proper value with relative errors on the order of 10 exp -12 .

SAND-75-0152 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Cdc 6600 Subroutine for Bessel Functions.
D. E. Amos, and S. L. Daniel. Sep 75, 26p
Contract AT(29-1)-789

Descriptors: *Computer codes, *B codes, *Bessel functions, *Computer calculations, Cdc computers, Fortran.
Identifiers: ERDA/990200, CDC-6600 computers.

Subroutine BESI implements the power series, the asymptotic expansion for x implies infinity, and the uniform asymptotic expansion for nu implies infinity for I/sub nu /(x). For pairs (nu ,x) not covered by one of these formulas, nu is raised by an integer (never more than 36) so that the backward recursive Miller algorithm can be normalized by one of these formulas. The order is then reduced by backward recursion on the three-term recursion relation. Sequences are also handled in this fashion, except in the region covered by the asymptotic expansion for x implies infinity and the region x < exp 1 / sub 2 covered by the series where two starting values are obtained from the appropriate expansion. The normalizing relation is always computed first with the leading term tested for under- or over-flow, where appropriate, before any extensive computation is done. Scaled values exp(-x)I/ sub nu /(x) are also computed as an option. These features make the routine very robust, giving good results whenever the function value is within the exponent range of the machine. Large orders (in excess of 10,000) are possible with relative errors on the order of 10 exp -12.

SAND-75-0211 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Using Deroot/Step, Intrp to Solve Ordinary Differential Equations.
M. K. Gordon. Apr 75, 13p
Contract AT(29-1)-789

Descriptors: *Differential equations, *Numerical solution, *Computer codes, *D codes, I codes, Programming.
Identifiers: ERDA/990200.

For abstract, see NSA 7504

SAND-75-0316 PC **A09**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Computational Methods for Single Server Queues with Interarrival and Service Time Distributions of Phase Type.
C. C. Carson. Jun 75, 189p
Contract AT(29-1)-789

Descriptors: *Computer codes, *M codes, Computer calculations, Distribution, Fortran, Length, Markov processes, Queues, S codes.
Identifiers: ERDA/990200, *Queueing theory.

General phase distributions are probability distributions of the time until absorption in finite-state, absorbing Markov chains. This dissertation considers some of the ramifications of using these distributions in the analysis of a single server queue. Such distributions allow the use of Markov chains for systems with fairly general interarrival and service time distributions. Their importance, however, lies not only in the Markovian structure they introduce, but also in the practical results which can be obtained within that structure. One such result is the determination of the distribution of the maximum queue length during a busy period of the PH/sup x//PH/1 queue. Knowledge of this distribution can be valuable in both the analysis and the design of queueing systems. This distribution can be computed for any queue which has the structure of a Markov chain, and an algorithm to obtain it for the PH/sup x//PH/1 queue is displayed. The recur-

sive solution of the steady-state equations for a large class of PH/sup x//PH/1 queues is also presented. This result is programmed for the computer, and the program and sample results are displayed. Various aspects of the steady-state distribution, a means for determining it in cases which cannot be handled recursively, and the computation of related distributions are discussed. In queues with service time distributions ofphase type, the distributions for various waiting times take on nice forms. In particular, in a finite capacity system, these distributions are themselves of phase type and can be efficiently computed.

SAND-75-0450 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Solving Systems of Nonlinear Equations.
L. F. Shampine, and M. K. Gordon. Aug 75, 25p
Contract AT(29-1)-789

Descriptors: *Computer codes, *Q codes, *Nonlinear systems, *Numerical solution, Equations.
Identifiers: ERDA/990200, *Roots of equations.

The reader is introduced to the problem of obtaining roots of systems of nonlinear equations. Some methods are discussed along with some of their more obvious difficulties and relative merits. The basic ideas of the code QN are exposed and the reader instructed in its use. Details of the implementation are included for reference. Some numerical experiments are described to place the performance of the code in perspective.

SAND-75-0525 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
New Capability for the Root Solver Qn.
L. F. Shampine, and M. K. Gordon. Oct 75, 13p
Contract AT(29-1)-789

Descriptors: *Computer codes, *Q codes, *Equations, *Numerical solution, Algebra, Cdc computers, Fortran, Nonlinear systems.
Identifiers: ERDA/990200.

The root solver QN is made much more efficient for systems of equations with a band structure. It is easy to modify it further to deal with more general sparsity patterns. Some minor alterations in the original code with respect to the detection of limiting precision are also described. This report supplements and assumes familiarity with SAND--75-0450.

SAND-75-0539 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Systemized Collection of Codes for Solving Two-Point Boundary-Value Problems.
M. R. Scott, and H. A. Watts. Nov 75, 37p
Contract AT(29-1)-789

Descriptors: *Nonlinear problems, *Numerical solution, Boundary conditions, Computer codes, Invariant imbedding, Performance.
Identifiers: ERDA/990200, *Two point boundary value problems.

A systematized collection of codes for solving linear and nonlinear two-point boundary-value problems is presented. The techniques are based on initial-value methods and include an orthonormalization procedure, invariant imbedding, and shooting. The codes are portable and are designed with user convenience the primary objective. Examples are presented to illustrate the performance of the codes.

SAND-75-0545 PC **A08**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Brief Instructions for Using Mathlib (Version 6.0).
R. E. Jones, and C. B. Bailey. Feb 76, 165p
Contract AT(29-1)-789

Descriptors: *Sandia laboratories, CDC computers, Computer codes, Fortran, Libraries.
Identifiers: ERDA/990200, *MATHLIB computer program.

The Sandia Numerical Mathematical Subroutine Library (MATHLIB) consists of a number of dependable, high-quality, general-purpose mathematical computing routines. This report provides a brief description of how to select and use each routine in the current library (version 6.0) on the CDC 6600. (ERA citation 01:015367)

SAND-75-0578 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Threedy Difference Method.
D. L. Hicks, H. S. Lauson, and M. M. Madsen.
Jan 76, 37p
Contract AT(29-1)-789

Descriptors: *Computer codes, *Wave propagation, Gases, Liquids, Solids, T codes, Three-dimensional calculations.
Identifiers: ERDA/990200, *THREEDY computer program.

THREEDY is a three-dimensional wave propagation code which employs operator splitting. This report describes the difference method in THREEDY. (ERA citation 01:012312)

SAND-75-5125 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Quality Software for Non-Stiff Ordinary Differential Equations.
L. F. Shampine. 1975, 4p Rept no. CONF-750902-1

Descriptors: *Differential equations, *Computer codes, Comparative evaluations, D codes, Numerical solution, Programming, R codes.
Identifiers: ERDA/990200.

The safety of computer codes is discussed, i.e., the ability to diagnose or otherwise cope with mistakes or misuse of the code. The state of software development in this area is exemplified through discussion of the specific codes DE and RKF45.

SAND-75-5184 PC **A04**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Solving Non-Stiff Ordinary Differential Equations: The State of the ART.
L. F. Shampine, H. A. Watts, and S. M. Davenport. 73p Rept no. CONF-7410107-1

Descriptors: *Differential equations, *Numerical solution, Computer codes, Testing.

For abstract, see NSA 31 12, number 35665.

SAND-75-5214 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
New Capability for de/Step,intrp.
M. K. Gordon. 1975, 6p Rept no. CONF-751014-1

Descriptors: *Computer codes, *D codes, *Nonlinear problems, *Numerical solution, *Differential equations, Numerical solution.
Identifiers: ERDA/990200.

A new code is presented for solving a nonlinear equation in which the unknowns are the solution of an initial-value problem for ordinary differential equations and its derivative. Solution techniques and existing codes for this problem are surveyed.

SAND-75-5729 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Quality Software for Non-Stiff Ordinary Differential Equations.
L. F. Shampine. 1975, 8p Rept no. CONF-750902-5

Descriptors: *Differential equations, *Computer codes, D codes, R codes.
Identifiers: ERDA/990200.

The state of software development via the code DE and the Runge-Kutta code RKF45 (members of a systematic collection called DEPAC) is outlined. The codes are considered as efficient as any for solving non-stiff ordinary differential equations.

SAND-75-5884 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Qmesh Mesh Generation Package.
R. E. Jones. 1975, 14p Rept no. CONF-751208-1

Descriptors: *Computer codes, *Q codes, *Finite element method, *Coordinates, Cdc computers, Two-dimensional calculations.
Identifiers: ERDA/990200, QMESH computer program.

A package of five programs centering around the highly flexible, powerful, two-dimensional mesh generation program QMESH is presented. Together, the five programs provide a tool for generation, bandwidth minimization, and display of meshes with Q4 or Q8 elements. The primary purpose of the package is generation of input for finite element analysis programs.

SAND-75-8238 PC **A02**/MF **A01**
Sandia Labs., Livermore, Calif.
Pquad: A Subroutine for the Calculation of Integrals over a Data Set.
R. E. Huddleston. Mar 75, 19p
Contract AT(29-1)-789

Descriptors: *Computer codes, *P codes, *Integrals, *Numerical solution, Least square fit, Polynomials.
Identifiers: ERDA/990200.

For abstract, see NSA 7504

SAND-75-8281 PC **A05**/MF **A01**
Sandia Labs., Livermore, Calif.
User'S Guide to the Sandia Mathematical Program Library at Livermore.
R. E. Huddleston, and T. H. Jefferson. Sep 75, 88p
Contract AT(29-1)-789

Descriptors: *Sandia laboratories, Computer codes, *Computer codes, *Bibliographies, Functions, Mathematics.
Identifiers: ERDA/990200.

The Sandia mathematical program library is a collection of general-purpose routines which are primarily mathematical in nature. Routines exist for the following applications: data fitting, eigenvalues and eigenvectors of matrices, Fourier transforms, linear algebraic equations, linear programming and game theory, numerical quadrature, numerical sorting, ordinary differential equations, special functions, zeros of functions and optimization, zeros of polynomials, and library error check routine and user options. Routines are listed alphabetically, with abstract and a description of parameters.

SAND-76-0062 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
CDC 6600 Subroutines for Integrals of (Sin T)/T, (Cos T)/T, K/sub O/(T)
D. E. Amos, and S. L. Daniel. Feb 76, 12p
Contract AT(29-1)-789

Descriptors: *Computer codes, *Integrals, C codes, Cdc computers, Computer calculations, I codes, Polynomials, S codes, Series expansion.
Identifiers: ERDA/990200, CDC-6600 computers.

Subroutines for the sine integrals Si(x), si(x), the cosine integral of Ci(x), and integrals of K sub 0 (t) on (0,x) and (x,infinity) are described. Chebyshev expansions, asymptotically scaled for small and large x, are implemented for each of the functions. (ERA citation 01:015370)

SAND-76-0125 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
CDC 6600 Subroutine for the Gamma Function
D. E. Amos. Apr 76, 8p
Contract AT(29-1)-789

Descriptors: *Computer codes, *Gamma function, CDC computers.
Identifiers: ERDA/990200, CDC-6600 computers, Computations.

The gamma function is computed on a basic interval (2,3) and extended to (0,10) by forward and backward recursion. The logarithm of the gamma function is computed and exponentiated for arguments greater than 10. Values for positive integer arguments up to 100 are stored and returned from a table look-up. The reflection formula is applied for noninteger, negative arguments. (ERA citation 01:022356)

SAND-76-0283 MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Convolution Method for Least-Squares-Fit Smoothing and Differentiation of Digital Data
H. H. Madden, and D. G. Schreiner. Aug 76, 58p
Contract E(29-1)-789
Microfiche copies only.

Descriptors: *Data analysis, Computer codes, Errors, Least square fit, Polynomials.
Identifiers: ERDA/990200.

The technique of least-squares-fit-to-a-polynominal smoothing of uniformly spaced digital data by convoluting the data with a smoothing array is reviewed. The use of digital computers for this type of numerical filtering and for determining smoothed derivatives was first discussed by Savitzky and Golay (Anal. Chem. 36, 1627 (1964)). The report presents methods for extending the widths of the convolution arrays beyond the 25-point-width maximum of Savitzky and Golay. It also gives corrections to errors in their paper. Three new algebraic equations are derived that can be used to determine the convolution array coefficients for determining the smoothed first, second, and third derivative values by least-squares-fitting to a quadratic/cubic polynominal. Two simple tests for determining errors in least-squares-fit convolution arrays are given. The use of these convolution arrays for processing digital data is illustrated by examples that make use of a Rutherford backscattering spectrum from a cobalt molybdate catalyst. (ERA citation 02:008882)

SAND-76-0364 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Stepwise Regression
R. L. Iman. Dec 76, 47p
Contract E(29-1)-7899

Descriptors: *Computer codes, Data analysis, Fortran, Manuals, S codes, Statistics.
Identifiers: ERDA/990200, *Regression analysis.

STEPWISE Regression is a description of a new multiple regression program. This program will provide for either a forward or backward solution to multiple regression problems. This document is designed for users of the STEPWISE program. (ERA citation 02:031729)

SAND-76-0370 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Quality of Runge--Kutta Formulas
L. F. Shampine. Jul 76, 32p
Contract AT(29-1)-789

Descriptors: *Differential equations, Accuracy, Computer codes, Errors, Numerical solution, Programming.
Identifiers: ERDA/990200, *Computer software, *Runge-Kutta method.

Critical evaluation of mathematical software is essential for the designation of items worthy of general acceptance and for the production of improved software. In the case of codes to solve the initial-value problem for ordinary differential equations, the usual procedure is to compare performance on a set of test problems. The value of such comparisons hinges on the hypothesis that the performance in nearly all respects depends only on the behavior of the solutions, not the form of the equations themselves. Unfortunately, this is not realistic for codes based on Runge--Kutta methods. Confronted with the fact that changing the form of an equation without altering its solution can reverse the relative efficiency of two Runge--Kutta formulas, how can one decide which formula to use. Relative behavior is predicted "on the average" and applied to assessing the quality of Runge--Kutta formulas and their error estimators. This conceptual tool and other aspects of quality illustrated in the generation of new formulas of high quality. 3 figures, 2 tables. (ERA citation 02:002249)

SAND-76-0389 PC **A05**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Accuracy Property of Certain Hyperbolic Difference Schemes
D. L. Hicks, and M. M. Madsen. Dec 76, 84p
Contract E(29-1)-789

Descriptors: *Differential equations, *Finite difference method, Accuracy, Computer codes, Numerical analysis, Numerical solution, One-dimensional calculations, Shock waves, Wave propagation.
Identifiers: ERDA/990200, *Hyperbolic differential equations.

An accuracy property called the CFL1 property is shared by several successful difference schemes. It appears to be a property at least as important as the property of higher-order accuracy for hyperbolic difference schemes when weak solutions (e.g., shocks) are sought. Investigation of this property leads to suggestions of ways to improve the accuracy in such wavecodes as WONDY, CHARTD, and THREEDY. 10 figures. (ERA citation 02:023869)

SAND-76-0392 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Detecting Stiffness with the Fehlberg (4,5) Formulas
L. F. Shampine, and K. L. Hiebert. Sep 76, 17p
Contract E(29-1)-789

Descriptors: *Differential equations, Computer codes, Numerical solution.
Identifiers: ERDA/990200, Runge-Kutta method, Numerical integration.

The Fehlberg (4,5) formulas appear to be the most effective Runge-Kutta formulas of moderate order for the solution of non-stiff ordinary differential equations. A simple, cheap scheme is developed for codes based on these formulas which detects stiffness with considerable reliability. If a user accidentally or unknowingly tries to integrate a stiff problem, a code with this scheme can warn him that it will be extremely inefficient and that he should switch to a code aimed specifically at such problems. (ERA citation 02:008883)

SAND-76-0448 MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Ridge Regression
R. L. Iman. Jan 77, 33p
Contract EY-76-C-04-0789
Microfiche copies only.

Descriptors: *Computer codes, Fortran, Mathematics, R codes.
Identifiers: ERDA/990200, *Regression analysis, *Ridge regression.

Ridge Regression is a description of a new multiple regression program. This program provides for a backward solution to multiple regression problems and will give the ridge regression solution for the full model. This document has been designed for users of the ridge regression program. (ERA citation 02:033567)

SAND-76-0560 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Solving Sturm--Liouville Eigenvalue Problems
P. B. Bailey, M. K. Gordon, and L. F. Shampine. Oct 76, 39p
Contract E(29-1)-789

Descriptors: *Computer codes, *Sturm-liouville equation, Algorithms, Cdc computers, Eigenfunctions, Eigenvalues, Errors, Numerical solution, Performance, S codes, Singularity.
Identifiers: ERDA/990200, Sleign computer program.

A code SLEIGN is presented to compute the eigenvalues and eigenfunctions of the Sturm--Liouville problem (d/dx) (p(x) (dpsi(x)/dx)) + (q(x) + lambdar(x)) psi(x) = 0 on (a,b), A sub 1 psi(a) + A sub 2 p(a)psi'(a) = 0, and B sub 1 psi(b) + B sub 2 p(b)psi'(b) = 0. Infinite intervals and singularities of the coefficient functions at endpoints are handled automatically. An estimate of the true error in the eigenvalue is obtained with each eigenvalue. This report provides a general description of the algorithm, its implementation, and performance. It also describes and exemplifies the use of the subroutine SLEIGN. 1 table. (ERA citation 02:012134)

SAND-76-0585 PC **A06**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Practical Solution of Ordinary Differential Equations by Runge--Kutta Methods
L. F. Shampine, and H. A. Watts. Dec 76, 106p
Contract E(29-1)-789

Descriptors: *Computer codes, *Differential equations, Algorithms, Cdc computers, Comparative evaluations, Fortran, Numerical solution, Programming, R codes.
Identifiers: ERDA/990200, Computer calculations, Runge-Kutta method.

All those factors bearing on the creation of a high-quality Runge--Kutta code for the solution of ordinary differential equations are studied. These include the selection of a formula based on many theoretical and experimental measures of quality; the various aspects of constructing efficient, reliable algorithms; and the design of convenient but flexible software. A code, RKF45, is presented as a concrete realization of the conclusions of the study. 29 tables. (ERA citation 02:025720)

SAND-76-0636 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Solving Ordinary Differential Equations for Simulation
L. F. Shampine. Nov 76, 11p
Contract E(29-1)-789

Descriptors: *Differential equations, Numerical solution, Simulation.
Identifiers: ERDA/990200, Runge-Kutta method, Computerized simulation.

Criteria for choosing a method for the numerical solution of ordinary differential equations for simulation problems are outlined. Then two kinds of Runge--Kutta formulas which are particularly efficient at doing those things expected at Runge--Kutta formulas are presented. These formulas perform better than do the Adams methods. Pairs of third- and fourth-order Runge--Kutta formulas are discussed. (ERA citation 02:015632)

SAND-76-0648 PC **A05**
Sandia Labs., Albuquerque, N.Mex.
Collection of Equations for Low-Degree Least-Squares Polynomials
E. L. Clark, Jr. Apr 77, 89p
Contract EY-76-C-04-0789

Descriptors: *Computer codes, *Least square fit, Fortran, L codes, M codes, S codes.
Identifiers: ERDA/990200, Polynomials.

The least-squares normal equations are solved for general functions having one to three coefficients that occur linearly. Expressions are given for evaluating the coefficients of the most useful low-degree least-squares polynomials. Simplified equations are derived for smoothing and differentiating data that is equally spaced in the independent variable. It is shown that a least-squares polynomial, if fit to an odd number of equally spaced points and evaluated at the midpoint of the fit, acts as a digital filter. Equations for the frequency response of the filter are given and expressions for the filter weights are derived which permit more efficient smoothing than is possible with conventional techniques. 5 figures, 2 tables. (ERA citation 02:040725)

SAND-76-5572 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.

Computational Solution of Nonlinear Two-Point Boundary-Value Problems
M. R. Scott, and H. A. Watts. 1977, 22p Rept no. CONF-770914-1
Contract EY-76-C-04-0789
Symposium on computers in chemical engineering, Vysoke Tatry, Czechoslovakia, Sep 1977.

Descriptors: *Boundary value problems, *Computer codes, *Differential equations, Algorithms, Cdc computers, Chemical reaction kinetics, Chemical reactors, Fortran, Fuel cells, Heat transfer, Mass transfer, Newton method, Nonlinear problems, Numerical solution, S codes.
Identifiers: ERDA/990200, *Two point boundary value problems, *Nonlinear differential equations.

A working computer code, called SUPOR Q, which solves quite general nonlinear two-point boundary value problems, is described. The nonlinear problem is replaced by a sequence of linear problems by applying quasilinearization (Newton's method) to the nonlinear differential operator. Each linear two-point boundary value problem is solved by an initial-value procedure which combines the well-known technique of superposition with a process called orthonormalization. 3 tables. (ERA citation 02:057814)

SAND-76-8038 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Approximation Technique for Functions of Several Variables
R. E. Humphrey. Aug 76, 23

Descriptors: *Computer codes, *Functions, Algorithms, Data, Cdc computers, Extrapolation, F codes, Fortran, Interpolation, Least square fit, Numerical solution, Polynomials, Three-dimensional calculations.
Identifiers: ERDA/990200, *Approximation.

A numerical technique is described for constructing a function of several variables which best approximates a set of empirical data. The technique preserves the local characteristics of the data and provides a means for interpolation and extrapolation of the data which does not require the data points to be located over an orderly structured grid of values. A digital computer program which performs the required numerical computations is included. 2 tables. (ERA citation 02:012136)

SAND-76-8209 PC **A05**/MF **A01**
Sandia Labs., Livermore, Calif.
User's Guide to the Sandia Mathematical Program Library at Livermore
R. E. Huddleston, and T. H. Jefferson. Mar 76, 98p
Contract AT(29-1)-789

Descriptors: *Computer codes, Sandia laboratories, Libraries, Manuals.
Identifiers: ERDA/990200, *Mathematical programming, *Subroutines.

The Sandia Mathematical Program Library is a collection of general-purpose mathematical subroutines which are maintained within Sandia on a quick service basis. This document is intended to be a reference guide for using the library at Sandia Laboratories, Livermore. (ERA citation 01:015371)

SAND-76-9231 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Art of Writing a Runge--Kutta Code
H. A. Watts, and L. F. Shampine. 1976, 15p
Contract E(29-1)-789

Descriptors: *Differential equations, *Programming, Algorithms, Computer codes, Numerical solution, Performance, R codes.
Identifiers: ERDA/990200, *Rung-Kutta method.

The problem considered is the solution of u' = f(x,u) for x between a and b with u(a) given. Runge--Kutta methods and when to use them are briefly described. Choice of step size is important. Characteristics of several codes employing Runge--Kutta methods are listed; the characteristics vary. Aspects of the algorithms discussed include error control, step size, external limits, scale of the problem, computer arithmetic, accuracy, and output. Characteristics of the code RFK45 are given. (ERA citation 02:021510)

SAND-77-0023 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Initial Step for an ODE Solver
L. F. Shampine. Jan 77, 9p
Contract E(29-1)-789

Descriptors: *Differential equations, Computer codes, Numerical solution.
Identifiers: ERDA/990200, Computer programming.

Every code for solving ordinary differential equations (ODE's) in a step-by-step manner must somehow obtain an initial step size. This step is a critical one because it is relatively easy for the code to select subsequent step sizes. Supplying an initial step size is an annoyance for the user at best, and it may result in an exceedingly bad value when the user does not know how to proceed. Problems with some previous methods for determining initial steps are discussed, and a new scheme is described which does not share earlier difficulties. (ERA citation 02:025722)

SAND-77-0162 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
User/Programmer Guide for UCMD 52: Superimposition of Rectangles by Polygons
K. E. Wiegandt. Feb 77, 20p
Contract EY-76-C-04-0789

Descriptors: *Computer codes, *Computer graphics, Diagrams, Size, U codes.
Identifiers: ERDA/990200, UCMD 52 computer program, Polygons.

This document describes program UCMD 52--an Applicon AGS/870 User Command for superimposing selected rectangles of nonzero X and Y length with a polygon or path identified by the component mode in effect at execution time. 3 figures. (ERA citation 02:040726)

SAND-77-0210 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Interactive Data Manipulation Program FAWTEK User Guide
W. B. Boyer. Feb 77, 31p
Contract EY-76-C-04-0789

Descriptors: *Computer codes, Data acquisition systems, Data processing, Electron beams, F codes, Sandia laboratories.
Identifiers: ERDA/990200, ERDA/640301, FAWTEK computer program.

The interactive data acquisitio and manipulation program FAWTEK is described. The program allows users of the electron beam data acquisition facility to control the R7912 digitizers and to perform a variety of mathematical operations on data arrays. Commands are entered in a high-level language via a Tektronix 4010 terminal console. Each command directive, aling with its associated parameters, is described in detail. (ERA citation 02:061839)

SAND-77-0364 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Location Errors in Angle-Measuring and Distance-Measuring Systems
E. A. Aronson. May 77, 36p
Contract EY-76-C-04-0789

Descriptors: *Computer codes, Coordinates, Cdc computers, Errors, Fortran, Measuring methods, T codes, Weighting functions.
Identifiers: ERDA/990200, *Statistical analysis.

Methods are described for the location of an object by using angle-measuring systems, distance-measuring systems, or a mix of the two. With reasonable assumptions on the statistics of the data errors in these systems, an analysis is presented which yields the statistics of the errors in object location; a data weighting scheme is shown which minimizes the variance of the location errors; and, as an aid to designers of such systems, a computer program is described which computes and plots location error contours for desired configurations. 11 figs., 1 table. (ERA citation 02:053584)

SAND-77-0413C PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Software for Ordinary Differential Equations
L. F. Shampine. 1977, 24p Rept no. CONF-770210-2
Contract EY-76-C-04-0789
A.A. advancement of science conference, Denver, Colorado, United States of America (USA), 20 Feb 1977.

Descriptors: *Differential equations, *Computer codes, Numerical solution, Programming.
Identifiers: ERDA/990200, *Computer software, Computer calculations.

A brief overview of the present situation of computer codes for the solution of differential equations is given. Suggestions as to the code appropriate for a particular problem are included. (ERA citation 02:044677)

SAND-77-0612 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
CDC 6600 Subroutine for Normal Random Variables
D. E. Amos. Apr 77, 7p
Contract EY-76-C-04-0789

Descriptors: *Statistics, *Programming, Cdc computers, Computer codes, R codes.
Identifiers: ERDA/990200, CDC 6600 computers, *Normal density functions, Subroutines.

A value y for a uniform variable on (0,1) is generated and a table of 96-percent points for the (0,1) normal distribution is interpolated for a value of the normal variable x(0,1) on 0.02 less than or equal to y less than or equal to 0.98. For the tails, the inverse normal is computed by a rational Chebyshev approximation in an appropriate variable. Then X = x sigma + mu gives the X(mu ,sigma) variable. (ERA citation 02:042329)

SAND-77-0683 PC **A04**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Solving Linear Least Squares Problems Using SODS/SUDS/CODS
H. A. Watts. Jun 77, 72p
Contract EY-76-C-04-0789

Descriptors: *Computer codes, *Least square fit, Algorithms, C codes, Cdc computers, Computer calculations, L codes, Matrices, Numerical solution, O codes, S codes, T codes.
Identifiers: ERDA/990200.

Numerical methods (which are based on orthogonal Householder transformations) and computer codes for solving linear least-squares problems are described. Over-determined, under-determined, and equality-constrained least-squares problems are examined. Brief instructions for using the codes are provided in the form of computer listings of the introductory comments from the codes. Furthermore, sample programs illustrate usage of the codes and demonstrate their performance on various test problems. (ERA citation 02:061840)

SAND-77-0767 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Sandia Laboratories Technical Capabilities: Computation Systems
Dec 77, 25p
Contract EY-76-C-04-0789

Descriptors: *Sandia laboratories, CDC computers, Computer graphics, Computers, Hybrid computers, Simulation, Uses.
Identifiers: ERDA/990200.

This report characterizes the computation systems capabilities at Sandia Laboratories. Selected applications of these capabilities are presented to illustrate the extent to which they can be applied in re-

search and development programs. 9 figures. (ERA citation 03:032504)

SAND-77-0871 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Linear Algebraic Equation Polyalgorithm for the CDC 6600 and 7600. A User's Guide for LEQSOL
R. J. Hanson, and J. A. Wisniewski. Aug 77, 48p
Contract EY-76-C-04-0789

Descriptors: *Computer codes, Equations, Algebra, Algorithms, Cdc computers, Fortran, Iterative methods, L codes, Matrices, Numerical solution.
Identifiers: ERDA/990200, *Linear algebraic equations, *Computer calculations, LEQSOL computer program, CDC-6600 computers, CDC-7600 computers.

A guide for persons who must compute numerical solutions of linear algebraic systems of equations is presented. Subprogram usage instructions are presented. Five often-occurring Fortran program examples arising from linear algebraic equations are listed. These are the following: solving Ax = b, computing matrix products A exp -1 D or EA exp -1 , iterative refinement, and determinant evaluation. A final example illustrates an analysis of a poorly conditioned problem. Some discussion of how to deal with constraint requirements on the solution should this occur is also presented. The subprogram for solving the systems is LEQSOL( ). The code has additional features beyond those of its Sandia Math Library counterpart SAXB( ). One feature is to provide an estimate of the accuracy of the computed solution. The subprogram LEQSOL( ) is considerably more efficient than SAXB( ) for large values of N. 3 figures, 1 table. (ERA citation 03:007791)

SAND-77-0898 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Basic Linear Algebra Subprograms for Fortran Usage
C. L. Lawson, R. J. Hanson, D. R. Kincaid, and F. T. Krogh. Oct 77, 41p
Contract EY-76-C-04-0789

Descriptors: *Algebra, B codes, CDC computers, Computer codes, Fortran, IBM computers, Univac computers.
Identifiers: ERDA/990200, *Linear algebra, *Matrices(Mathematics), Assembly languages, IBM-360/67 computers, CDC-6600 computers, CDC-7600 computers, Univac-1108 computers.

A package of 38 low-level subprograms for many of the basic operations of numerical linear algebra is presented. The package is intended to be used with FORTRAN. The operations in the package are dot products, elementary vector operations, Givens transformations, vector copy and swap, vector norms, vector scaling, and the indices of components of largest magnitude. The subprograms and a test driver are available in portable FORTRAN. Versions of the subprograms are also provided in assembly language for the IBM 360/67, the CDC 6600 and CDC 7600, and the Univac 1108. (ERA citation 03:025597)

SAND-77-1129 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Solving Ordinary Differential Equations in SPEAKEASY
L. F. Shampine. Aug 77, 30p
Contract EY-76-C-04-0789

Descriptors: *Computer codes, *Differential equations, Algorithms, Analytical solution, S codes.
Identifiers: ERDA/990200, *SPEAKEASY programming language, *Computer calculations.

SPEAKEASY does not have within it FORTRAN-type functions. A function like sin(x) is defined as a table of values at specified points and is held in the computer as an array. Because of this, the differential equation to be solved is defined only at certain points. This problem must be confronted; the algorithms and the code employing them do quite well at meeting the requirements for acceptable solution. The algorithms used are described, and step size, order, and errors are discussed. Several examples are given, along with a listing of subroutine SPKODE. (ERA citation 03:007792)

SAND-77-1328 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Modifications of SUPORT, a Linear Boundary Value Problem Solver: Part I. Pre-Assigning Orthonormalization Points, Auxiliary Initial Value Problem, Disk or Tape Storage
B. L. Darlow, M. R. Scott, and H. A. Watts. Aug 77, 27p
Contract EY-76-C-04-0789

Descriptors: *Boundary value problems, *Computer codes, Numerical solution, Programming, S codes.
Identifiers: ERDA/990200, SUPORT computer program, *Two point boundary value problems, Numerical integration.

Some new capabilities of the code SUPORT, which solves linear two-point boundary-value problems are discussed. One modification now allows the user to pre-assign a set of orthonormalization points. In this mode of operation, the code does not check when orthonormalization should take place, so care must be taken in selecting the points to produce a satisfactory solution. Some guidelines are offered in using this option. Another capability allows the user easily to solve a boundary-value problem which depends on the solution of a nonlinear initial-value problem. This solution is achieved by simultaneous integration of all equations. Another capability allows the user the option of utilizing disk or tape storage for intermediate computations, and thereby reduce the in-core storage requirements for a large problem. 4 tables. (ERA citation 03:025599)

SAND-77-1390 PC **A05**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
AMOSLIB: A Special Function Library Version 9/77
D. E. Amos, and S. L. Daniel. Sep 77, 80p
Contract EY-76-C-04-0789

Descriptors: *Computer codes, Airy functions, Bessel functions, Gamma function, Integrals, Sandia Laboratories, Statistics.
Identifiers: ERDA/990200.

This document gives the call list and parameter definitions for 59 computer codes dealing with Bessel functions, error functions, gamma functions, beta functions, sine and cosine integrals, root solvers, statistical distributions, etc. The following codes are included: AIRY, DAIRY, BAIRY, DBAIRY, BESJ01, BESI01, BESY01, BESK01, BESJ, BESI, SBESI, BESYN, BESKN, BERBEI, KRKI, DKRKI,CJ01BS, CJYHBS, JROOTS, FINTK0, ERF, ERFC, RERF, CERF, INERFC, RIERFC, GAMLN, GAMFN, GAMIC, GAMTL, BETALN, BETAIC, BETBIC, SININT, COSINT, XNEWT, FINVER, FNORM, RVNORM, FNORMB, FCHISQ, FNCHI2, FCENT, FNCT, FDNCT, FBIVTS, FBIVTQ, FMLTVT, FFDIST, FNCF, FNCFQ, FMLTVF, FCIRCV, THA, GAUS8, DATAD, ERRCHK, ONECHK, and ERXSET. (ERA citation 03:029997)

SAND-77-1441 PC **A11**/MF **A01**
Sandia Labs., Albuquerque, NM.
Brief Instructions for Using the Sandia Mathematical Subroutine Library (Version 7.2)
K. H. Haskell, and R. E. Jones. Jun 78, 246p
Contract EY-76-C-04-0789

Descriptors: *Computer codes, *Sandia laboratories.
Identifiers: ERDA/990200, CDC-6600 computers, CDC-7600 computers, NOS system, Mathematical programming, Computer programming, Subroutine libraries.

The Sandia Numerical Mathematical Subroutine Library consists of a number of dependable, high-quality, general-purpose mathematical computing routines. This report provides a brief description of how to select and use each routine in the current library (version 7.2) on the CDC 6600, 7600, and NOS systems. (ERA citation 04:004927)

SAND-77-1518 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
CDC 6600 Subroutine for the Logarithm of the gamma Function
D. E. Amos. Oct 77, 7p
Contract EY-76-C-04-0789

Descriptors: *Computer codes, *Gamma function, Asymptotic solutions, CDC computers, G codes, Recursion relations, Series expansion.
Identifiers: ERDA/990200, CDC-6600 computers, Logarithms.

The gamma function is computed on a basic interval (2,3) by a rational Chebyshev approximation and extended to (0,8) by forward or backward recursion. The logarithm of the gamma function on (8,1000) is computed by another rational Chebyshev approximation, and the asymptotic expansion to two terms is used for arguments larger than 1000. Values for nonzero integer arguments up to 100 are stored and returned from a table look-up. (ERA citation 03:013581)

SAND-77-1690 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Modifications of SUPORT, a Linear Boundary Value Problem Solver. Part II. Inclusion of an Adams Integrator
B. L. Darlow, M. R. Scott, and H. A. Watts. Nov 77, 23p
Contract EY-76-C-04-0789

Descriptors: *Boundary value problems, *Computer codes, Comparative evaluations, Integrals, Modifications, Numerical solution, S codes.
Identifiers: ERDA/990200, *Two point boundary value problems, SUPORT computer program.

This report discusses a new capability of the code SUPORT, which solves linear two-point boundary-value problems. An Adams integration process was added to complement the presently available Runge--Kutta integrator. Circumstances in which each method will produce the more efficient numerical solution to the boundary-value problem are discussed. The conclusions are supported by numerical evidence on several sample problems. 7 tables. (ERA citation 03:020814)

SAND-77-1832 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Common-Cause Analysis Using SETS
R. B. Worrell, and D. W. Stack. Dec 77, 15p
Contract EY-76-C-04-0789

Descriptors: *Mechanical structures, *System failure analysis, Computer codes, C codes.
Identifiers: ERDA/420200, *Common cause analysis.

Common-cause analysis was developed at the Aerojet Nuclear Company for studying the behavior of a system that is affected by special conditions and secondary causes. Common-cause analysis is related to fault tree analysis. Common-cause candidates are minimal cut sets whose primary events are closely linked by a special condition or are susceptible to the same secondary cause. It is shown that common-cause candidates can be identified using the Set Equation Transformation System (SETS). A Boolean equation is used to establish the special conditions and secondary cause susceptibilities for each primary event in the fault tree. A transformation of variables (substituting equals for equals), executed on a minimal cut set equation, results in replacing each primary event by the right side of its special condition/secondary cause equation and leads to the identification of the common-cause candidates. (ERA citation 03:029000)

SAND-77-2032 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Mathematical Programming Updating Method Using Modified Givens Transformations and Applied to LP Problems. A User's Guide for SLPMG()
R. J. Hanson, and J. A. Wisniewski. Mar 78, 32p
Contract EY-76-C-04-0789

Descriptors: *Computer codes, *Linear programming, Algorithms, Fortran, Matrices, S codes, Transformations.
Identifiers: ERDA/990200.

An efficient and numerically stable method is presented for the problem of updating an orthogonal decomposition of a matrix of column (or row) vectors. The fundamental idea is to add a column (or row) analogous to adding an additional row of data in a linear least-squares problem. A column (or row) is dropped by a formal scaling with the imaginary unit, sqrt (-1), followed by least-squares addition of the column (or row). The elimination process for the procedure is successive application of the Givens transformation in modified (more efficient) form. These ideas are illustrated with an implementation of the revised simplex method. The algorithm is a general purpose one that does not account for any particular structure or sparsity in the equations. Some suggested computational tests for determining signs of various controlling parameters in the revised simplex algorithm are mentioned. A simple means of constructing test cases and some sample computing times are presented. Three appendices are provided to aid the user of the FORTRAN subprogram SLPMG( ) implementing this method. These are, respectively, a short usage writeup for SLPMG(), usage examples, and some comparisons with other software. 1 figure, 2 tables. (ERA citation 03:032515)

SAND-77-2044 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
SLEIGN: An Eigenvalue--Eigenfunction Code for Sturm--Liouville Problems
P. B. Bailey. Jan 78, 31p
Contract EY-76-C-04-0789

Descriptors: *Computer codes, *Sturm-Liouville equation, Algorithms, Eigenfunctions, Eigenvalues, Performance, S codes, Singularity.
Identifiers: ERDA/990200, SLEIGN computer program.

A code, SLEIGN, is presented for the computation of eigenvalues and eigenfunctions of Sturm--Liouville problems of the form (pPSI')' + (q + lambda r)PSI = 0 on (a,b), with A sub 1 PSI(a) + A sub 2 p(a)PSI'(a) = 0 and B sub 1 PSI(b) + B sub 2 p(b)PSI'(b) = 0. Infinite intervals and other kinds of singularities are handled completely automatically. The accuracy of the computed eigenvalue is realistically estimated. An initial guess for the eigenvalue is not necessary but is used effectively if available, and there is no possibility of accidentally computing the wrong eigenvalue. In addition to describing the basic algorithms employed in the code this report also explains, with examples, how the code is used. A short summary of its performance on a representative set of problems is also included. This code is a new version of an earlier one with the same name. (ERA citation 03:032516)

SAND-77-8274 PC **A07**/MF **A01**
Sandia Labs., Livermore, Calif.
User's Guide to the Sandia Mathematical Program Library at Livermore
T. H. Jefferson. Oct 77, 126p
Contract EY-76-C-04-0789

Descriptors: *Mathematics, Sandia laboratories, Computer codes, Differential equations, Eigenvalues, Eigenvectors, Fourier transformation, Functions, Least square fit, Libraries, Mathematical operators, Matrices, Nonlinear problems, Polynomials, Quadratures, Vectors.
Identifiers: ERDA/990200.

The Sandia Mathematical Program Library is a collection of general-purpose mathematical subroutines which are maintained within Sandia on a quick-service basis. This document is intended to be a reference guide for using the library at Sandia Laboratories, Livermore. (ERA citation 03:020817)

SAND-78-0465C MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Data Fitting with Insufficient Data
K. Haskell. 1978, 18p Rept no. CONF-780224-1
Contract EY-76-C-04-0789
Rio Grande ACM winter meeting, LasCruces, NM, USA, 10 Feb 1978, Portions of document are illegible.

Descriptors: *Least square fit, Computer calculations, Hermite polynomials, Numerical solution, Polynomials.
Identifiers: ERDA/990200, LSEI computer program, *Curve fitting.

It is desired to fit a curve through a series of data in the least squares sense. A four-step procedure using piecewise polynomials is detailed. In the example given, Hermite cubics are used to parametrize the data. Calculation shows that it is necessary to constrain the curve, and then solve the constrained least-squares problem. A computer code (LSEI) has now been developed to handle this type of problem. 3 figures. (ERA citation 03:030001)

SAND-78-0522 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, NM.
Modifications of SUPORT, a Linear Boundary Value Problem Solver. Part III. Orthonormalization Improvements
M. E. Lord, and H. A. Watts. May 78, 28p
Contract EY-76-C-04-0789

Descriptors: *Boundary-value problems, Computer codes, Cdc computers, Fortran, Modifications, Numerical solution, Orthogonal transformations, Recursion relations, S codes.
Identifiers: ERDA/990200, SUPORT computer program, *Two point boundary value problems.

Some improvements in the orthonormalization process for the SUPORT code, which solves linear two-point boundary-value problems, are discussed. Various alternatives for a linear dependence test are also considered. A scheme which reduces the frequency of the linear dependence test is incorporated, and numerical results are shown for several sample problems. 5 tables. (ERA citation 04:002131)

SAND-78-0736 MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Renormalization Methods for Several Marching Algorithms Used in the Direct Solution of Elliptic Equations
A. J. Russo. Apr 78, 30p
Contract EY-76-C-04-0789
Microfiche copies only.

Descriptors: *Computer codes, *Differential equations, Algorithms, CDC computers, Computer calculations, Fortran, Numerical solution, P codes, Renormalization, T codes.
Identifiers: ERDA/990200, *Elliptic differential equations.

The use of marching methods for the solution of elliptic partial differential equations is generally limited by an inherent instability. This limitation can, to a great extent, be overcome by renormalization procedures appropriate to the particular marching method. Two such methods and suitable renormalizations for them are described. Sample computer codes are included to illustrate the implementation of the renormalized algorithms. 2 figures. (ERA citation 03:049322)

SAND-78-1352 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, NM.
Better Software for ODEs
L. F. Shampine. Aug 78, 13p
Contract EY-76-C-04-0789

Descriptors: Calculation methods, Computer codes, Efficiency, Errors, Numerical solution, Programming.
Identifiers: ERDA/990200, *Ordinary differential equations.

An extremely simple change to existing software for the solution of ordinary differential equations (ODEs) provides the information needed to use the codes more reliably and efficiently. Since codes for the solution of ODEs do not even attempt to control their true (global) error directly, it is very common that users solve their problem more than once with different error tolerances and compare the results to ascertain their true accuracy. Even with the best codes this procedure can lead to wrong conclusions. The proposal made here considerably reduces the chances of such a mistake. How frequently the user wishes output strongly affects some important methods for the solution of ODEs. The proposal monitors the effects of requesting output too often and informs the user when he is employing the code inefficiently. (ERA citation 04:004928)

SC-M-388 HC A02 MF **A01**
Sandia Labs., Albuquerque, N. Mex.
Announcement of the Avaliabliity of Erf and Erfc, Mathematical Routines for Computing the Error Function and Complementary Error Function.
J. E. Vogel. Jul 70, 4p

Descriptors: *Error functions, *Computer programming, Computation.
Identifiers: ERF computer program, ERFC computer program, CDC 6600 computers.

For abstract, see NSA 2417

SC-M-70-232 HC A02 MF **A01**
Sandia Labs., Albuquerque, N. Mex.
Announcement of the Availabliity of Sever: A Computer Routine for Symmetric Matrix Eigenvalues and Eigenvectors with Error Bounds.
W. R. Gavin. Apr 70, 4p

Descriptors: *Matrix algebra, *Programming(Computers).
Identifiers: SEVER computer program, Eigenvalues, Eigenvectors.

For abstract, see NSA 2411

SC-M-70-26 PC **A04**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Sever: A Routine for Computing Symmetric Matrix Eigenvalues and Eigenvectors with Error Bounds.
W. R. Gavin. Mar 70, 58p

Descriptors: *Matrices, *Computer calculations, Algorithms, Cdc computers, Computer codes, Eigenvalues, Eigenvectors, Errors, Mathematics, Numerical solution, S codes.

For abstract, see NSA 31 05, number 13474.

SC-M-70-724 PC **A04**/MF **A01**
Sandia Labs., Albuquerque, N. Mex.
Runkut- Runge-Kutta Integrator of Systems of First Order Ordinary Differential Equations
R. E. Jones. Nov 70, 51p

Descriptors: *Computer programs, *Differential equations.

For abstract, see NSA 26 18, number 45054.

SC-M-70-83 HC A04 MF **A01**
Sandia Labs. Albuquerque, N.Mex.
Survey of Three-Dimensional Finite Difference Forms of Heat Equation.
Jimmie H. Smith. Mar 70, 63p*

Descriptors: *Atmosphere entry, Simulation, *Heat transfer, *Partial differential equations, *Integration, *Numerical analysis, Computer programs, Reviews.
Identifiers: *Finite difference theory, Heat equation.

For abstract, see NSA 2411

SC-RR-70-615 PC **A04** MF **A01**
Sandia Labs., Albuquerque, N. Mex.
Efficient Runge-Kutta Codes
L. F. Shampine, and H. A. Watts. Sep 70, 63p

Descriptors: *Computer programs.

For abstract, see NSA 25 03, number 06250.

SC-RR-720657 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N. Mex.
Routine for Unconstrained Optimization
L. F. Shampine. Sep 72, 20p

Descriptors: *Computer programs, *Optimization.

For abstract, see NSA 27 01, number 02293.

SLA-73-1060 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex. (Usa).
Solving Ordinary Differential Equations with Ode, Step, and Intrp
L. F. Shampine, and M. K. Gordon. Jan 74, 26p
Contract AT(29-1)-789

Descriptors: *Differential equations, *Analytical solution, Computer codes, I codes, O codes, S codes.
Identifiers: AEC.

For abstract, see NSA 29 07, number 17956.

SLA-73-334 PC **E03**/MF **A01**
Sandia Labs., Albuquerque, N. Mex.
Cdc 6600 Routines for Some Cumulative, Multivariate Distribution Functions
D. E. Amos, and S. L. Daniel. Mar 73, 66p

Descriptors: *Computer codes, *Distribution functions, *Cdc computers, *Programming.
Identifiers: AEC.

For abstract, see NSA 28 07, number 17703.

SLA-73-627 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N. Mex.
Computer Programs for Calculating Certain Factors Associated with Normal Random Variables
D. E. Amos, and S. L. Daniel. Jun 73, 35p

Descriptors: *Integral equations, *Computer calculations, *Computer codes, Integral equations, Equations, G codes, O codes, T codes.
Identifiers: AEC.

For abstract, see NSA 28 08, number 20585.

SLA-74-198 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex. (Usa).
Global Error Estimation for Ordinary Differential Equations.
L. F. Shampine, and H. A. Watts. 1974, 30p Rept no. CONF-740511-2

Descriptors: Computer codes, Differential equations, Efficiency, Errors, Reliability, Resolution.

For abstract, see NSA 30 01, number 02251.

SLA-74-270 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex.
Curve Fitting by Polynomials in One Variable.
L. F. Shampine, S. M. Davenport, and R. E. Huddleston. Jun 74, 28p
Contract AT(29-1)-789

Descriptors: *Computer codes, *P codes, *Polynomials, *Least square fit, Data processing, Diagrams.

For abstract, see NSA 30 08, number 23330.

SLA-74-5256 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N.Mex. (Usa).
Cdc 6600 Subroutines Ibess and Jbess for Bessel Functions I/sub nu /(X) and J/sub nu /(X), X Greater Than or Equal to 0, nu Greater Than or Equal to 0.
D. E. Amos, S. L. Daniel, and M. K. Weston. 20p Rept no. CONF-740511-1

Descriptors: *Computer codes, *I codes, *Bessel functions, Computer codes, Asymptotic solutions, Cdc computers, J codes, Power series.

For abstract, see NSA 29 12, number 31613.

SLL-73-252 PC **A02**/MF **A01**
Sandia Labs., Albuquerque, N. Mex. Sandia Labs., Livermore, Calif.
Cdc 6600 Codes for the Bessel Functions J sub 0 (Z) and J sub 1 (Z) for Arbitrary Values of the Complex Variable Z
D. E. Amos, and R. E. Huddleston. Jul 73, 24p
Contract AT(29-1)-789

Descriptors: *Bessel functions, Computer codes, *Computer codes, *B codes, Cdc computers.
Identifiers: AEC.

For abstract, see NSA 28 08, number 20589.

SLL-73-302 PC **A02**/MF **A01**
Sandia Labs., Livermore, Calif. (Usa).
Calculation of Discrete Fourier Transforms
D. B. Nelson. Dec 73, 24p
Contract AT(29-1)-789

Descriptors: *Fourier transformation, *Computer calculations, *Computer codes, *F codes, Programming.
Identifiers: AEC.

For abstract, see NSA 29 06, number 15094.

SLL-73-305 PC **A03**/MF **A01**
Sandia Labs., Albuquerque, N.Mex. (Usa).
TJMAR1: Fortran Subroutine for Nonlinear Least Squares Parameter Estimation.
T. H. Jefferson. Mar 74, 29p
Contract AT(29-1)-789

Descriptors: *Computer codes, *T codes, *Least square fit, *Programming, Algebra, Cdc computers, Data, Fortran.

For abstract, see NSA 30 01, number 02255.

SLL-74-200 PC **A03**/MF **A01**
Sandia Labs., Livermore, Calif.
Modified Gram Schmidt Orthogonalization and Its Applications, Including Constrained Least Squares Approximation.
J. F. Lathrop, and D. E. Amos. Apr 74, 37p
Contract AT(29-1)-789

Descriptors: *Equations, *Numerical solution, Analytical solution, Computer calculations, Computer codes, Fortran, Least square fit, Mathematics, Vectors.

For abstract, see NSA 30 06, number 18058.

SLL-74-214 PC **A02**/MF **A01**
Sandia Labs., Livermore, Calif. (Usa).
Cdc 6600 Routines for the Interpolation of Data and of Data with Derivatives.
R. E. Huddleston. Apr 74, 25p
Contract AT(29-1)-789

Descriptors: *Computer codes, *H codes, Cdc computers, Interpolation, Numerical solution, P codes.

For abstract, see NSA 29 12, number 31614.

SLL-74-234 PC **A02**/MF **A01**
Sandia Labs., Livermore, Calif.
Constrained Least Squares Polynomial Fits.
R. E. Huddleston. May 74, 21p
Contract AT(29-1)-789

Descriptors: *Computer codes, *C codes, *Least square fit, *Mathematics, Polynomials.

For abstract, see NSA 30 04, number 12086.

STAN-CS-75-496 PC **A07**/MF **A01**
Stanford Univ., Calif. Dept. of Computer Science.
Iterative Block Lanczos Method for the Solution of Large Sparse Symmetric Eigenproblems.
R. R. Underwood. May 75, 138p Rept no. SU-326P30-41

Descriptors: *Matrices, *Numerical solution, *Computer codes, *M codes, Algorithms, Eigenvalues, Fortran, Iterative methods.
Identifiers: ERDA/990200, *Sparse matrices.

This dissertation discusses the development, implementation, and application of an algorithm to solve the following problem: Compute accurate approximations to the r least eigenvalues of a large, sparse symmetric matrix A, where r is much less than n, the order of A. Application of common algorithms for solving general symmetric eigenproblems would require excessive computer time. The method considered is organized about a block Lanczos algorithm, which is an extension and generalization of a method originally proposed by Lanczos. Numerical examples and a listing of the computer program are included.

SU-IPR-507 PC **A03**/MF **A01**
Stanford Univ., Calif. Inst. For Plasma Research.
On-Line Spline Fitting
O. Buneman. Feb 73, 27p
Contract AT(04-3)-799

Descriptors: *Data processing, *Algorithms, *Iterative methods, *Matrices, Computer codes, Data, Diagrams, Functions, Mathematics, Three-dimensional calculations.
Identifiers: AEC.

For abstract, see NSA 28 10, number 26845.

SU-326-P-30-29 PC **A03**/MF **A01**
Stanford Univ., Calif. (Usa). Dept. Of Computer Science.
Solution of Sparse Indefinite Systems of Equations and Least Squares Problems
C. C. Paige, and M. A. Saunders. Nov 73, 49p
Rept no. STAN-CS-73-399
Contract AT(04-3)-326

Descriptors: *Equations, *Analytical solution, Algorithms, Computer codes, Fortran, Least square fit, Matrices.
Identifiers: AEC.

For abstract, see NSA 29 07, number 17958.

SU-326-P30-40 PC **A03**/MF **A01**
Stanford Univ., Calif. Dept. of Computer Science.
Adaptive Finite Difference Solver for Nonlinear Two Point Boundary Problems with Mild Boundary Layers
M. Lentini, and V. Pereyra. Nov 75, 43p

Descriptors: *Boundary-value problems, *Differential equations, *Finite difference method, Accuracy, Algorithms, Errors, Nonlinear problems, Numerical solution.
Identifiers: ERDA/990200, *Two point boundary value problems, *PASVAR computer program.

A variable-order, variable-step finite difference algorithm for approximately solving m-dimensional systems of the form y' = f(t,y), t contained in (a,b), subject to the nonlinear boundary conditions g(y(a),y(b)) = O is presented. A program, PASVAR, implementing these ideas was written, and the results on several test runs are presented together with comparisons with other methods. The main features of the new procedure are its ability to produce very precise global error estimates, which in turn allow a very fine control between desired tolerance and actual output precision; non-uniform meshes, allowing an economical and accurate treatment of boundary layers and other sharp changes in the solutions; and the combination of automatic variable order (via deferred corrections) and automatic (adaptive) mesh selection, which produces, as in the case of initial-value problem solvers, a versatile, robust, and efficient algorithm. 3 tables. (ERA citation 01:015372)

SU-326P18X10 PC **A03**/MF **A01**
Stanford Univ., Calif.
Systems Optimization Project. Progress Report, 1 October 1975--30 June 1976
G. B. Dantzig, R. W. Cottle, and R. B. Wilson. Jul 76, 36p
Contract EY-76-S-03-0326-018

Descriptors: *Optimization, Algorithms, Computer codes, Equilibrium, Linear programming, Nonlinear programming, Research programs.
Identifiers: ERDA/990200.

The purpose of the Systems Optimization Laboratory is to advance the power of optimization methods on a broad front. This ranges from basic research on the abstract mathematical theory of optimization to the implementation in efficient, tested, documented computer codes of the algorithmic procedures developed from the basic theory. In the past year the Laboratory's basic research work has focused on three main topics: further development of techniques of large-scale linear programing, an emphasis motivated by the intensive demand for optimizing energy planning systems over time; completion of general-purpose codes, using several different algorithmic methods, for nonlinear programing, and development of a variety of special-purpose algorithms and codes for specially-structured nonlinear programing problems; and the development of algorithms for fixed-point and equilibrium problems. Part I describes the Laboratory's published output appearing during the reporting period in its series of technical reports, and is confined to those reports funded completely or in part by the ERDA contract, except as noted. Part II summarizes the Laboratory's software development activities. Part III reports more generally on the Laboratory's other activities: staff and visitors, the role of the Workshop, etc., and also includes a brief summary of the Laboratory's recent work on the development of the PILOT series of models for policy analysis of investment problems in the energy sector. A complete listing of the Laboratory's reports, accompanied by abstracts of their contents, is provided in Part IV. The report is administrative in nature, with no data. (ERA citation 02:042331)

SU-326P30-52 PC **A10**/MF **A01**
Stanford Univ., Calif. Dept. of Computer Science.
Algorithms for Sparse Matrix Eigenvalue Problems
J. G. Lewis. Mar 77, 212p Rept no. STAN-CS-77-595
Contract EY-76-S-03-0326-030
Thesis.

Descriptors: *Computer codes, *Matrices, *Eigenvalues, Algorithms, D codes, Fortran, Numerical solution.
Identifiers: ERDA/990200, *Sparse matrices.

Eigenvalue problems for an n by n matrix A where n is large and A is sparse are considered. A is assumed to be unstructured: it cannot be reordered to have narrow bandwidth, nor can linear systems of the form Ax = b be solved by special techniques. The eigenvalue problem for such a matrix is well-solved only when A is symmetric and the eigenvalues to be computed are among the largest or smallest eigenvalues of A. The Lanczos algorithm offers a very good solution in this case. Algorithms are proposed for three difficult problems: computing one (or a few) eigenvalue(s) of a symmetric matrix where the eigenvalue(s) are not near the end of the spectrum; computing a number of interior eigenvalues of a symmetrix matrix; computing one (or a few) eigenvalues(s) of a non-symmetric matrix. Two algorithms for finding a single interior eigenvalue are investigated. An algorithm using the Lanczos algorithm to solve the linear systems which arise in the Rayleigh quotient iteration is much superior. The algorithm for finding many eigenvalues is built directly upon the Lanczos algorithm without reorthogonalization. It is found that the Lanczos algorithm is suitable for very large problems only if a limited reorthogonalization is included. A block generalization of the unreorthogonalized Lanczos algorithm is developed, and necessary conditions for its stability are given. The investigations and analyses are largely empirical. The third algorithm reduces the non-symmetric eigenproblem to a series of symmetric eigenvalue problems. It is a Rayleigh quotient-like iteration using singular vectors. A theoretical analysis of the local convergence properties of the algorithm is given. There are two obvious computational approaches, one by way of a poorly conditioned extreme eigenvalue problem, the other by way of an interior eigenvalue problem. The latter approach is superior. 3 figures, 25 tables. (ERA citation 02:053585)

TREE-1138(Rev.1) MF **A01**
Idaho National Engineering Lab., Idaho Falls.
MOCARS: A Monte Carlo Code for Determining Distribution and Simulation Limits and Ranking System Components by Importance
S. D. Matthews, and J. P. Poloski. Aug 78, 117p
Contract EY-76-C-07-1570
Microfiche copies only.

Descriptors: *Computer codes, *Statistics, Reactor safety, CDC computers, Fault tree analysis, Fortran, Functions, M codes, Monte Carlo method, Probability, Sampling.
Identifiers: ERDA/990200, ERDA/220900, MOCARS computer program, Cyber-76/173 computers.

MOCARS is a computer program designed for use on the Idaho National Engineering Laboratory (INEL) CDC CYBER 76-173 computer system that uses Monte Carlo techniques to determine the distribution and simulation limits for a function. In use, the MOCARS program randomly samples data from any of the 12 different user-specified probability distributions and either evaluates a user-specified function or cut set system unavailability using the sample data. After data ordering, the values at various quantities and associated confidence bounds are calculated for output. If the cut set unavailability function is evaluated, MOCARS can determine the importance ranking for components in the unavailability calculation. Frequency and cumulative distribution histograms from the sample data are also available for output on microfilm. 39 figures, 4 tables. (ERA citation 04:002134)

TREE-1216 PC **A02**/MF **A01**
Idaho National Engineering Lab., Idaho Falls.
User's Description of Second-Order Error Propagation (SOERP) Computer Code for Statistically Independent Variables
N. D. Cox, and C. F. Miller. Feb 78, 20p
Contract EY-76-C-07-1570

Descriptors: *Computer codes, *Statistics, CDC computers, Errors, Fortran, IBM computers, S codes, Series expansion.
Identifiers: ERDA/990200, SOERP commputer program, Random variables.

The development and use of second-order error propagation equations for the first four moments of a function of independently distributed random variables are discussed. The implementation of a computer code (SOERP) for solving these equations with up to 30 component variables is also presented. (ERA citation 03:032520)

UCCND-CSD-INF-72 PC **A06**/MF **A01**
Oak Ridge Gaseous Diffusion Plant, Tenn.
Comparative Study of Computer Codes for Integrating Ordinary Differential Equations.
D. F. McGonigal. Dec 75, 112p
Contract W-7405-eng-26

Descriptors: *Differential equations, Computer codes, *Computer codes, *Comparative evaluations, Analytical solution, Computer calculations, Errors, Time dependence.
Identifiers: ERDA/990200, *Numerical integration.

An attempt is made to investigate some of the commonly available codes for solving ordinary first order differential equations. The types of codes tested were one-step methods, multistep methods, and extrapolation techniques. A common set of twenty-five test problems was established as a standard by which to test the codes. Each code was clocked to determine the quantity of computer time necessary to carry out the integrations and the results of each integration were compared to the analytical solution, were known, to check its accuracy. This examination revealed that, of the codes tested, the extrapolation codes proved to function in the fewest units of time and also produced the most accurate results at medium to high order error requirements.

UCCND-CSD-INF-74 PC **A03**/MF **A01**
Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.
Utility Routines for Tridiagonal Matrices.
J. E. Park. Nov 75, 36p
Contract W-7405-eng-26

Descriptors: *Computer codes, *F codes, *Matrices, Computer codes, *Finite difference method, Matrices, Comparative evaluations, Fortran, Ibm computers, T codes.
Identifiers: ERDA/990200.

A family of FORTRAN subroutines to perform several operations on tridiagonal coefficient matrices and related vectors, matrices, and linear systems is presented. Detailed descriptions of the subroutine arguments are given. Results of two test cases are presented and compared to solutions obtained by using the standard routine DMATEQ. 1 figure, 4 tables.

UCID-17099 PC **A04**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
Survey of Applied and Computational Mathematics at LLL
J. Chang, M. Ekstrom, and F. Fritsch. 11 Jun 76, 56p
Contract W-7405-eng-48

Descriptors: *Mathematics, *Programming, Computer codes, Computers, Lawrence livermore laboratory, Research programs.
Identifiers: ERDA/658000, ERDA/990200.

A summary of current activities in applied and computational mathematics at the Lawrence Livermore Laboratory is given. It is evident from the survey that there is a very broad spectrum of research and development in this area of mathematics. However, only a small percentage of the total effort is directly involved with fundamental research. The Laboratory is advised to adopt a formal policy to establish and support a research program in applied and computational mathematics. Coordination of related efforts is needed, and steps toward this are recommended. In addition, a study of interactions between mathematical methods and computer architectures is necessary for the Laboratory's ever-increasing requirement for computational capability. 5 figures, 3 tables. (ERA citation 02:011833)

UCID-17252 PC **A03**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
Computer Implementation of Glimm's Method
G. A. Sod. Aug 76, 30p
Contract W-7405-Eng-48

Descriptors: *Computer codes, *Differential equations, *Shock tubes, Cdc computers, Fortran, G codes, Iterative methods, Numerical solution, Shock waves, Wave propagation.
Identifiers: ERDA/990200, ERDA/658000, *Glimm method, Hyperbolic differential equations, CDC-7600 computers.

Glimm's method deals with the solution of a nonlinear hyperbolic equation. The method is rooted in the constructive proof by Glimm (Comm. Pure Appl. Math., 18, 697 (1965)) that such systems have weak solutions. The Riemann problem is examined. The iterative method of Godunov, the selection of random numbers, and the actual implementation of Glimm's method are discussed. Usage of the FORTRAN subroutine GLIMM is explained; a flow chart is provided. Graphical results are presented for three shock tube problems with 100 spatial grid points. The time for a typical problem is 10 seconds on a CDC 7600 computer. 13 figures. (ERA citation 02:006414)

UCID-17267 PC **A05**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
Programs NAES and SS: User-Oriented Programs for Solving Nonlinear Algebraic Equations and Ordinary Differential Equations
H. K. McCue. 11 Aug 76, 89p
Contract W-7405-Eng-48

Descriptors: *Computer codes, *Differential equations, Cdc computers, Equations, Fortran, N codes, Nonlinear problems, Numerical solution, S codes.
Identifiers: ERDA/990200, *NAES computer program, *SS computer program, Fortran 4 programming language, *Nonlinear algebraic equations, Ordinary differential equations.

Program NAES (Nonlinear Algebraic Equation Solver) is a Fortran IV program used to solve the vector equation f(x) = 0 for x. Two areas where Program NAES has proved to be useful are the solution for initial conditions and/or set points of complex systems of differential equations and the identification of system parameters from steady-state equations and steady-state data. Program SS (State Space) is a Fortran IV program used to solve a system of first-order, ordinary differential equations with a minimum of specialized coding. Program SS automatically provides a tabular listing and line-printer plots of the outputs. In addition, provisions are made to perform one-time preintegration calculations, read specialized input data, establish specialized output labels, handle piecewise continuous f(x(t),t), make x--y plots of output variables, and record the minima/maxima of specified variables. Subroutines were written to provide delay, level detection with hysteresis, and solutions to implicit equations. 26 figures, 1 table. (ERA citation 02:015633)

UCID-17357 PC **A03**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
Genvar: A General Linear Computer Program for Model Forecasting and Variance Analysis
S. D. Stratton. 12 Jan 77, 39p
Contract W-7405-ENG-48

Descriptors: *Computer codes, *Forecasting, *Least square fit, Mathematical models, Cdc computers, Fortran, G codes, Matrices.
Identifiers: ERDA/990200, CDC 7600 computers, *Genvar computer program, *Analysis of variance.

This report describes GENVAR, an interactive computer program which can perform a least-squares fit to the matrix equation beta X = Y, where X is a matrix of observable inputs and Y is a vector of observable outcomes for the input values. The program is controlled by teletype-writer, and is written in LRLTRAN for compilation by CHAT and execution on a CDC 7600. The report describes the way the program operates as well as ways GENVAR can be used to make statistically considered forecasts. Samples of graphic output and the source code listing (GLMVAR) are provided. 2 figures, 3 tables. (ERA citation 02:033570)

UCID-17623 PC **A02**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
BIHI: Bicubic Hermite Interpolation Code
R. P. Dickinson, Jr, and R. E. Carlson. Oct 77, 7p
Contract W-7405-ENG-48

Descriptors: *Computer codes, *Interpolation, B codes, Cdc computers, Equations of state, Functions, Hermite polynomials, Rectangular configuration.
Identifiers: ERDA/990200, BIHI computer program.

BIHI is a bivariate interpolation code which constructs a piecewise bicubic function that interpolates to a given set of data values arranged over a rectangular grid. 1 figure. (ERA citation 03:009514)

UCID-17862 PC **A02**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
BICUBE: Bicubic Spline Interpolation Code
R. P. Dickinson, Jr, and R. E. Carlson. Jul 78, 25p
Contract W-7405-ENG-48

Descriptors: *Computer codes, *Interpolation, B codes, Two-dimensional calculations.
Identifiers: ERDA/990200, *Spline interpolation, BICUBE computer program.

BICUBE is a program for constructing a bicubic spline surface through a given set of data points defined over a rectangular grid. In this sense BICUBE is a program for solving the 2-dimensional smooth surface interpolation problem. A brief discussion of bicubic spline interpolation is given first. Then a detailed description of the structure of BICUBE is provided, and the calling sequences of the principal subroutines are explained. Finally, an example of the use of BICUBE is given. 4 figures. (ERA citation 03:058097)

UCID-30001(Rev.2) PC **A03**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
Gear: Ordinary Differential Equation System Solver
A. C. Hindmarsh. 20 Aug 72, 44p
Contract W-7405-eng-48

Descriptors: *Differential equations, *Analytical solution, *Computer codes, *G codes.
Identifiers: AEC.

For abstract, see NSA 28 11, number 29453.

UCID-30003 PC **A02** MF **A01**
California Univ., Livermore. Lawrence Radiation Lab.
Gather- Interpolation Between Two Weighted Tabular Functions of One Variable
Arthur L. Edwards. 1 Apr 71, 12p
Contract W-7405-ENG-48

Descriptors: *Computer programs.

For abstract, see NSA 25 14, number 34487.

UCID-30006 PC **A02** MF **A01**
California Univ., Livermore. Lawrence Radiation Lab.
Wew- Solution of the Transcendental Equation, We/Sup W/ = X
F. N. Fritsch, R. E. Shafer, and W. P. Crowley. 1 Apr 71, 10p
Contract W-7405-ENG-48

Descriptors: *Computer programs.

For abstract, see NSA 25 17, number 41675.

UCID-3001(Rev.3) PC **A04**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.
Gear: Ordinary Differential Equation System Solver.
A. C. Hindmarsh. Dec 74, 72p
Contract W-7405-Eng-48

Descriptors: *Differential equations, *Numerical solution, *Computer codes, *G codes, Fortran.

For abstract, see NSA 31 06, number 15824.

UCID-30045 PC **A03**/MF **A01**
California Univ., Livermore (Usa). Lawrence Livermore Lab.
Solution of Banded Linear Systems.
A. C. Hindmarsh. 8 May 72, 37p
Contract W-7405-eng-48

Descriptors: *Equations, *Numerical solution, Algorithms, Computer codes, Matrices.

For abstract, see NSA 30 01, number 02259.

UCID-30045(Rev.1) PC **A03**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
Solution of Banded Linear Systems
A. C. Hindmarsh. Jun 78, 36p
Contract W-7405-ENG-48

Descriptors: *Computer codes, *Differential equations, B codes, CDC computers, Finite element method, Fortran, L codes, Matrices, Numerical solution, S codes.
Identifiers: ERDA/990200, Subroutines.

This report describes four subroutine packages, each of which carries out the direct solution of a system of linear equations for which the coefficient matrix is real and banded along the main diagonal. In each, the method of LU decomposition (without pivoting) is applied to the matrix; the solution is then obtained by back-substitution in a separate routine. The general case and the symmetric case are treated separately. For each of these, the case where the matrix resides entirely within core and the case where it resides in Large Core Memory are treated separately. This report supersedes the original report UCID-30045, dated May 1972. This revised report reflects changes made to the subroutine packages given herein, and corresponding changes to their usage instructions. The algorithms used have not been altered. 3 figures. (ERA citation 03:058098)

UCID-30050(Pt.2) PC **A03**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.
Construction of Mathematical Software. Part II. Some Examples of Mathematical Software.
R. E. von Holdt, R. P. Jr. Dickinson, and R. L. Pexton. 5 Dec 72, 30p
Contract W-7405-eng-48

Descriptors: *Pade approximation, *Computer codes, *Computers, *Programming, Equations, Functions, Mathematics.

For abstract, see NSA 30 12, number 34510.

UCID-30050(PT.5) PC **A02**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
Construction of Mathematical Software. Part V. Some Application Codes
T. Suyehiro, N. Davies, and G. . Hage. 14 Aug 72, 22p
Contract W-7405-ENG-48

Descriptors: *Computer programs, *Mathematics.
Identifiers: AEC.

For abstract, see NSA 27 08, number 19413.

UCID-30059 PC **A03**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
Gearb: Solution of Ordinary Differential Equations Having Banded Jacobian
A. C. Hindmarsh. May 73, 32p
Contract W-7405-eng-48

Descriptors: *Computer codes, *G codes, *Differential equations, *Computer calculations, Jacobian function, Matrices, Numerical solution.
Identifiers: AEC.

For abstract, see NSA 28 06, number 15063.

UCID-30059(Rev.2) PC **A03**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
GEARB: Solution of Ordinary Differential Equations Having Banded Jacobian
A. C. Hindmarsh. Jun 77, 39p
Contract W-7405-ENG-48

Descriptors: *Computer codes, *Differential equations, Algorithms, Cdc computers, D codes, G codes, Numerical solution.
Identifiers: ERDA/990200, GEARB computer program, Stiff differential equations, Numerical integration.

GEARB is a package of subroutines for the numerical solution of systems of ordinary differential equations in which the Jacobian matrix has a band structure. It is a modified version of the package described in GEAR: Ordinary Differential Equation System Solver, UCID-30001 (Rev. 3), and is intended primarily for stiff problems. The principal modification is the substitution of band matrix solution routines for the full matrix solution routines. This report describes the GEARB package briefly and gives instructions on its use. (ERA citation 02:055537)

UCID-30060(Rev.1) PC **A03**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
Banded Linear Systems with Pivoting
A. C. Hindmarsh. May 76, 30p
Contract W-7405-Eng-48

Descriptors: *Computer codes, *Equations, Cdc computers, D codes, Fortran, Matrices, Numerical solution, S codes.
Identifiers: ERDA/990200, CDC-7600 computers.

This report describes two subroutine packages for the direct solution of a system of linear equations in which the coefficient matrix is real and banded along the main diagonal. In each package, the method of LU decomposition with partial pivoting is applied to the matrix, and the solution of the linear system is then obtained by back-substitution in a separate routine. The band structure need not be symmetric. The first of the two packages is written in standard Fortran and deals with the case where the matrix resides in small-core memory. The second deals with the case where it resides in large-core memory on the CDC 7600. In both cases, the matrix is to be supplied to the routines by rows. 1 figure. (ERA citation 01:025175)

UCID-30077(Rev.1) PC **A03**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
EISPACK: User's Guide
R. P. Dickinson, Jr, and F. N. Fritsch. Nov 76, 46p
Contract W-7405-ENG-48

Descriptors: *Computer codes, *Eigenvalues, *Eigenvectors, *Matrices, Burroughs computers, Cdc computers, E codes, Fortran, Honeywell computers, Ibm computers, Pdp computers, Univac computers.
Identifiers: ERDA/990200, *Eispack computer program, Ansi Fortran.

EISPACK is a collection of subroutines, written in ANSI Standard Fortran, designed to compute the eigenvalues and eigenvectors for a variety of matrix problems. These codes form a complete eigensystem package, are representative of the state-of-the-art in speed and accuracy, and have been thoroughly tested and certified. This report is intended to simplify the task of determining which of the routines are to be used for solving the particular problem at hand. 5 tables. (ERA citation 02:033572)

UCID-30092 PC **A02**/MF **A01**
California Univ., Livermore (Usa). Lawrence Livermore Lab.
Zeroin: A Subroutine to Calculate One Real Zero of a Real Continuous Function.
L. J. Leonard. 11 Apr 74, 7p
Contract W-7405-eng-48

Descriptors: *Computer codes, *Z codes, Fortran.

For abstract, see NSA 30 02, number 05726.

UCID-30096 PC **A02**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.
Complex: A Program for Evaluating Expressions Containing Complex Variables.
R. J. Knox. 7 Oct 74, 11p
Contract W-7405-eng-48

Descriptors: *Computer codes, *M codes, Cdc computers, Functions, Mathematics, Variations.

For abstract, see NSA 31 03, number 08013.

UCID-30103 PC **A04**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.
Gap: A General Analysis and Plotting Program.
D. Y. F. Lai. 3 Dec 74, 64p
Contract W-7405-Eng-48

Descriptors: *Computer codes, *G codes, *Least square fit, Computer codes, Data processing, Diagrams, Interactive display devices, Plotters.
Identifiers: ERDA/990200.

GAP is an interactive computer program for analyzing and plotting data. Interacting with GAP, the user can input data from a teletypewriter or from a disk file, can reduce the data, and can plot the original and reduced data. He can reduce the data according to an equation, can fit the data (weighted or unweighted) by the least-squares method, and can approximate parameters in nonlinear equations. He can view the plots on a television monitor or print them as hardcopy, microfiche, or 35mm film. He can save his set of instructions from one run as a disk file, and then use them later to process other sets of data. GAP is written in Fortran and is available as an executable controllee on the CDC 7600 computers of the Livermore time-sharing system. Instructions are given for using GAP.

UCID-30112(Rev.1) MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
EPISODE: An Effective Package for the Integration of Systems of Ordinary Differential Equations
A. C. Hindmarsh, and G. D. Byrne. 1977, 69p
Contract W-7405-ENG-48
Microfiche copies only.

Descriptors: *Computer codes, *Differential equations, C codes, Cdc computers, E codes, Fortran, IBM computers, Numerical solution, T codes.
Identifiers: ERDA/990200, EPISODE computer program, Numerical integration.

EPISODE is a package of subroutines written in FORTRAN. When these subroutines are used together in the manner described here, they provide the numerical solution of the initial-value problem for systems of ordinary differential equations. EPISODE contains both a variable-step, variable-order implicit Adams method and a variable-step, variable-order backward differentiation method. Since the user may select either of these methods simply by assigning the appropriate value to a method flag, EPISODE can be used to solve either stiff or non-stiff problems. Similarly, the user also selects one of four corrector iteration methods to be used. The EPISODE package is supplied in double precision to users outside Lawrence Livermore Laboratory (LLL), but it contains the single-precision version imbedded in it. Conversion to single precision can be easily done with a converter subroutine, supplied with the package. Development and testing work on EPISODE has been done on both CDC equipment at LLL and IBM equipment at Argonne National Laboratory (ANL), and earlier versions have been in use for over three years. 3 figures. (ERA citation 02:040313)

UCID-30114 PC **A03**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.
Yale Sparse Matrix Package User'S Guide.
A. H. Sherman. 27 Aug 75, 50p
Contract W-7405-Eng-48

Descriptors: *Computer codes, *Y codes, *Matrices, *Computer calculations, *Equations, *Numerical solution, Cdc computers, Fortran.
Identifiers: ERDA/990200, Sparse matrices.

This report describes the structure and use of the Yale Sparse Matrix Package (YSMP) at LLL. The package is designed to solve systems of linear equations in which the coefficient matrices are large and sparse. The method used is Gaussian elimination (without pivoting for numerical stability), so that the package may be applied to the sparse linear systems arising in a wide variety of applications.

UCID-30116 PC **A03**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.
Gears: Solution of Ordinary Differential Equations Having a Sparse Jacobian Matrix.
J. W. Spellmann, and A. C. Hindmarsh. Aug 75, 41p
Contract W-7405-Eng-48

Descriptors: *Computer codes, *G codes, *Differential equations, *Numerical solution, Cdc computers, Fortran.
Identifiers: ERDA/990200, GEARS subroutines.

GEARS is a package of subroutines for the numerical solution of systems of ordinary differential equations in which the Jacobian matrix has a sparse structure. GEARS was created by merging modified versions of GEAR and the Yale Sparse Matrix Package (YSMP). Although the primary emphasis in GEARS is on stiff systems, it may be used, in general, for problems with various degrees of stiffness. As with GEAR, the GEARS package used either the implicit Adams methods or backward differentiation formulas for solving the system of equations. Also, the user has several options with regard to the Jacobian of the system.

UCID-30119 PC **A03**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.
Gearv: A Vectorized Ordinary Differential Equation Solver.
D. B. Morris, and A. C. Hindmarsh. 22 Oct 75, 41p
Contract W-7405-Eng-48

Descriptors: *Computer codes, *G codes, *Differential equations, *Numerical solution, Cdc computers, D codes, Fortran, Vectors.
Identifiers: ERDA/990200, GEARV subroutines, Numerical integration.

GEARV is a package of subroutines for the numerical solution of systems of ordinary differential equations, given the initial values. It is a vectorized version of the GEAR package (UCID-30001, Rev. 3), and is good for both stiff and nonstiff systems. The package contains both the implicit Adams methods and the backward differentiation formulas, or the methods of C.W. Gear, as options.

UCID-30119(Rev.1) MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
GEARV And GEARST: Vectorized Ordinary Differential Equation Solvers for the 7600 and STAR Computers
D. B. Morris, A. C. Hindmarsh, and P. F. Dubois. Dec 77, 40p
Contract W-7405-ENG-48

Descriptors: *Differential equations, Algorithms, Computer codes, G codes, Numerical solution, Vectors.
Identifiers: ERDA/990200, Ordinary differential equations, CDC-7600 computers, STAR-100 computers.

GEARV and GEARST are packages of subroutines for the numerical solution of systems of ordinary differential equations, given the initial values. Both are vectorized versions of the GEAR package (UCID-30001, Rev. 3), and are good for both stiff and nonstiff systems. Each package contains both the implicit Adams methods and the backward differentiation formulas, or the method of C. W. Gear, as options. GEARV is written for the CDC 7600 computer, with the use of STACKLIB and vector language features of the CHAT compiler at LLL. GEARST is written for the CDC STAR-100 computer, with the FENIX compiler. (ERA citation 03:032525)

UCID-30123 PC **A03**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.
Star "Basic" Mathematical Subroutines.
R. E. von Holdt. 18 Dec 75, 38p
Contract W-7405-Eng-48

Descriptors: *Computer codes, *F codes, Cdc computers, H codes, Mathematics.
Identifiers: ERDA/990200.

The following mathematical subroutines are described: FEXP (Full-Word Exponential Function), HEXP (Half-Word Exponential Function, FLOG (Full-Word Logarithm Function), HLOG (Half-Word Logarithm Function), FE2I (Full-Word Cos-Sin Function), HE2I (Half-Word Cos-Sin Function),

FR2P (Full-Word Rectangular-to-Polar Transformation Function), HR2P (Half-Word Rectangular-to-Polar Transformation Function), FSAT (Full-Word Arctangent Function), and HSAT (Half-Word Arctangent Function). Assembly language listings are provided for those beginning with F. 15 figures, 2 tables.

UCID-30130 PC **A02**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.
Preliminary Documentation of Gearib: Solution of Implicit Systems of Ordinary Differential Equations with Banded Jacobian.
A. C. Hindmarsh. Feb 76, 10p
Contract W-7405-Eng-48

Descriptors: *Computer codes, *Differential equations, G codes, Iterative methods, Numerical solution.
Identifiers: ERDA/990200, *GEARIB computer program.

This report is a preliminary version of documentation for a new package, GEARIB. The package solves systems of ordinary differential equations in the implicit form Ay = g, with A and the partial derivative of g with respect to y treated in band matrix form. (ERA citation 01:012313)

UCID-30134 PC **A02**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
Proposed ODEPACK Calling Sequence
A. C. Hindmarsh, and G. D. Byrne. May 76, 16p
Contract W-7405-Eng-48

Descriptors: *Differential equations, Computer codes, O codes.
Identifiers: ERDA/990200, *Computer programming, Computations.

A proposed list of calling sequence parameters is discussed for consideration in a possible systematized collection of ordinary differential equation solvers, tentatively referred to as ODEPACK. This sequence consists of a minimal list of eleven parameters and solver-dependent list of five more parameters. Proposed definitions of all of these parameters are given, and explanatory notes are provided. (ERA citation 01:025176)

UCID-30137 Not available NTIS
California Univ., Livermore. Lawrence Livermore Lab.
DEC/SOL: Solution of Dense Systems of Linear Algebraic Equations
A. C. Hindmarsh, L. J. Sloan, K. W. Fong, and G. H. Rodrigue. 24 Jun 76, 31p
Contract W-7405-Eng-48
Available from ERDA, P.O. Box 62, Oak Ridge, TN 37830, Attn: TIC.

Descriptors: *Equations, Computer codes, Fortran, Many-dimensional calculations, Matrices, Numerical solution.
Identifiers: ERDA/990200, *DEC computer program, *SOL computer program, CDC 7600 computers, Fortran 4 programming language, *Linear algebraic equations.

This report describes four versions of a pair of subroutines for solving N x N systems of linear algebraic equations. In each case, the first routine, DEC, performs an LU decomposition of the matrix with partial pivoting, and the second, SOL, computes the solution vector by back-substitution. The first version is in Fortran IV, and is derived from routines DECOMP and SOLVE written by C. B. Moler. The second is a version for the CDC 7600 computer using STACKLIB. The third is a hand-coded (Compass) version for the 7600. The fourth is a vectorized version for the CDC STAR. Comparative tests on these routines are also described. (ERA citation 02:015635)

UCID-30149 PC **A02**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
Preliminary Documentation of GEARBI: Solution of ODE Systems with Block-Iterative Treatment of the Jacobian
A. C. Hindmarsh. Dec 76, 16p
Contract W-7405-ENG-48

Descriptors: *Computer codes, *Differential equations, Cdc computers, Finite difference method, Fortran, G codes, Numerical solution.
Identifiers: ERDA/990200, Gearbi computer program.

A preliminary version of documentation for the GEARBI package is presented. This package solves systems of ordinary differential equations (initial value problem), with emphasis on stiff systems, in which the Jacobian matrix has a regular block structure. The package takes advantage of that structure and uses a block-iterative (block-SOR) method to solve the linear algebraic systems that arise. In all other respects, GEARBI is much the same as the GEAR package. (UCID-30001, Rev. 3). An earlier version of GEARBI was used for atmospheric kinetics-transport problems in one and two dimensions. (ERA citation 02:023874)

UCID-30150 PC **A03**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
Solution of Block-Tridiagonal Systems of Linear Algebraic Equations
A. C. Hindmarsh. Feb 77, 28p
Contract W-7405-ENG-48

Descriptors: *Computer codes, Equations, B codes, Cdc computers, D codes, Fortran, Matrices, Numerical solution, S codes.
Identifiers: ERDA/990200, *Linear algebraic equations, Computation.

The solution of linear systems with a block-tridiagonal structure is a very common requirement in many applications. This report describes two Fortran packages for solving such systems. The first is for the case when all the relevant blocks in the coefficient matrix can be stored at once. The second is for the case when they cannot; instead the equations are generated, one block-row at a time, by a user-supplied subroutine. The blocks are assumed to be full, and partial pivoting is done within block-rows only. (ERA citation 02:025725)

UCID-4671 PC **A03**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.
Game Trees, M and N Minimaxing, and the M and N alpha beta Procedure. Artificial Intelligence Group Report No. 3.
J. R. Slagle. 8 Nov 63, 49p

Descriptors: *L codes, *Efficiency, Computer codes, Programming.

For abstract, see NSA 30 04, number 12087.

UCRL-14541(Rev.1) HC A03 MF **A01**
California Univ., Livermore. Lawrence Radiation Lab.
Expals: Fortran Code for Exponential Approximation by Least Squares.
Gardner C. Douglas. 6 Mar 70, 49p

Descriptors: *Exponential functions, *Curve fitting, Computer programs, Least squares method, Iterative methods, Approximation(Mathematics).
Identifiers: EXPALS computer program.

For abstract, see NSA 2415

UCRL-51517 PC **A02**/MF **A01**
California Univ., Livermore (Usa). Lawrence Livermore Lab.
Constrained Minimization of a Function of Many Variables.
C. W. Radcliffe, and W. J. Comfort. 24 Jan 74, 22p
Contract W-7405-eng-48

Descriptors: *Computer codes, *Nonlinear problems, Boundary conditions, Scale invariance, Weighting functions.

For abstract, see NSA 29 12, number 31621.

UCRL-51878 PC **A02**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.
Numerical Inversion of the Fourier Transform: A Combination Trapezoidal and Filon Technique.
D. G. Dudley. 5 Aug 75, 17p

Descriptors: *Fourier transformation, Computer codes, *Computer codes, *L codes, Computer calculations, Fortran, Numerical solution, Quadratures.
Identifiers: ERDA/990200.

A method is presented for combining the features of trapezoidal integration with Filon's method in order to produce an efficient numerical inversion of the Fourier transform. A fully documented FORTRAN language subroutine is developed which allows transformation from either time to frequency or frequency to time.

UCRL-51958 PC **A04**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
Three-Dimensional Tensor-Product, Spline Interpolation Code (TPSIC)
D. V. Anderson. 19 Jan 76, 52p
Contract W-7405-Eng-48

Descriptors: *Computer codes, *Interpolation, Thermonuclear reactors, CDC computers, FORTRAN Magnetic fields, T codes, Tensors, Three-dimensional calculations.
Identifiers: ERDA/990200, ERDA/700202, *Spline interpolation, TPSIC computer code.

The one-dimensional, mth-order B-spline interpolation method originated by Schoenberg and developed by deBoor has been adapted for interpolation on multidimensional domains by Dickinson. A vector space of basis functions for the multidimensional domain is constructed by simple tensor product from the one-dimensional case. Use of the tensor product permits the efficient calculation of the interpolation coefficients that would otherwise be impracticable to perform. A very flexible data format is allowed in which derivatives or functional values may be used alternatively. Boundary conditions are not separately considered but are part of the general data supplied to the code. Results from the three-dimensional (3D) cubic spline interpolation of a known 5th-degree multinomial function on a grid are presented. The spline method used here is limited to orthogonal coordinate systems. One application of the code has been to interpolate the magnetic field (from a 3D grid) for various CTR plasma confinement applications. 2 figures. (ERA citation 01:018373)

UCRL-52127 PC **A03**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
Routines Using Associated Legendre Functions and Legendre Polynomials
31 Jan 77, 32p
Contract W-7405-Eng-48

Descriptors: *Computer codes, *Legendre polynomials, *Spherical harmonics, D codes, Fortran, Integrals, L codes, Series expansion, Y codes.
Identifiers: ERDA/990200, *Legendre functions.

Computer routines are described which involve Associated Legendre functions of the first kind. Included are a routine to expand functions in Legendre polynomials, routines for the real and imaginary parts of the spherical harmonics in spherical polar coordinates, derivatives of the Legendre polynomials and multiple integrals of Legendre polynomials P/sub k/(X) multiplied by a positive integer power of X. The derivations of the mathematical formulae used are included. (ERA citation 03:020826)

UCRL-75868 PC **A03**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.

Applications of Episode: An Experimental Package for the Integration of Systems of Ordinary Differential Equations.
A. C. Hindmarsh, and G. D. Byrne. Jun 75, 30p
Rept no. CONF-750902-3

Descriptors: *Computer codes, *E codes, *Differential equations, *Numerical solution, *Earth atmosphere, *Simulation, Cdc computers, Chemical reaction kinetics, Fortran.
Identifiers: ERDA/990200, EPISODE computer code.

A brief description, with examples of usage, is given of a new FORTRAN package called EPISODE, for the numerical solution of the initial-value problem for systems of ordinary differential equations. EPISODE contains both a variable-step, variable-order implicit Adams method and a variable-step, variable-order backward differentiation method. Since the user may select either of these methods simply by assigning the appropriate value to a method flag, EPISODE can be used to solve either stiff or nonstiff problems. Similarly, the user also selects one of four corrector iteration methods to be used. EPISODE was motivated by problems in atmospheric modeling at LLL in which chemical rate constants vary with time in an abrupt diurnal manner. Examples of such problems, and others, are given to illustrate the use and effectiveness of the program. Outside LLL the EPISODE package is being supplied in double precision, but contains the single precision version imbedded in it. Conversion to single precision can be easily done with a converter subroutine, supplied with the package.

UCRL-76671 PC **A02**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.
Quality Software for Ordinary Differentlal Equations at Lll.
A. C. Hindmarsh. Mar 75, 5p Rept no. CONF-750902-2

Descriptors: *Differential equations, *Numerical solution, Computer codes, Programming.
Identifiers: ERDA/990200, GEAR computer code, EPISODE computer code.

Work at LLL in the area of ordinary differential equations (initial value problem) has been motivated by the study of chemical kinetics systems and the treatment of systems of partial differential equations such as arise in atmospheric models. In both of these the ODE problem is typically stiff. Two general purpose codes, GEAR and EPISODE, are briefly described, along with several variants of them.

UCRL-76671(Rev.1) PC **A02**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
Quality Software for Ordinary Differential Equations at LLL
A. C. Hindmarsh. Feb 76, 6p Rept no. CONF-750902-11
Contract W-7405-Eng-48
80. national meeting of the American Institute of Chemical Engineers, Boston, Massachusetts, USA, 7 Sep 1975.

Descriptors: *Differential equations, *Computer codes, Chemical reaction kinetics, Lawrence livermore laboratory, Programming.
Identifiers: ERDA/990200, *Partial differential equations, Numerical integration.

Work in the area of ordinary differential equations (initial value problem) at Lawrence Livermore Laboratory is briefly discussed. The work was motivated by such problems as the study of chemical kinetics systems and the treatment of systems of partial differential equations (such as arise in atmospheric models) by the method of lines. Aspects of the codes GEAR, EPISODE, GEARB, EPISODEB, and block-SOR are presented. (ERA citation 01:015380)

UCRL-77062 PC **A03**/MF **A01**
California Univ., Livermore Lawrence Livermore Lab.

Generallzed Software for Partial Dlfferential Equations.
N. K. Madsen, and R. F. Sincovec. Jul 75, 48p

Descriptors: *Computer codes, *P codes, *Differential equations, *Numerical solution, *Nonlinear problems, *Computer calculations, Coupling, One-dimensional calculations, Programming.
Identifiers: ERDA/990200, *Partial differential equations.

This paper discusses generalizations of a previously developed software package for solving physically realistic coupled systems of nonlinear one-dimensional parabolic partial differential equations. Many rather sophisticated numerical techniques are implemented in a manner so as to provide ease of use and reliability. Numerical results are presented. (3 figures, 6 tables).

UCRL-78129 PC **A02**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
LLL Family of Ordinary Differential Equation Solvers
A. C. Hindmarsh. Apr 76, 25p
Contract W-7405-Eng-48

Descriptors: *Computer codes, *Differential equations, E codes, G codes, Numerical solution.
Identifiers: ERDA/990200, *GEAR computer program, *ODE computer program, *EPISODE computer program.

Two groups of programs were developed at LLL for the numerical solution of the initial value problem for systems of ordinary differential equations. The first includes the GEAR package. It is a general purpose, variable-order, automatic ODE solver, with eight different method options covering both stiff and nonstiff problem types. A number of variants of GEAR were also written in order to solve large stiff problems of various types. A newer and smaller group of programs is based on the EPISODE package, which resembles GEAR but is based on totally variable-step formulas. Most of the programs discussed are publicly available. 1 table. (ERA citation 01:025180)

UCRL-79328(Pt.1) PC **A03**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
ELIPTI Code: Part I
J. C. Taylor, and J. V. Taylor. 30 Mar 77, 32p
Rept no. CONF-770619-3
Contract W-7405-ENG-48
International symposium on computer methods for partial differential equations, Bethlehem, Pennsylvania, United States of America (USA), 22 Jun 1977.

Descriptors: *Computer codes, *Differential equations, Plasma instability, Algorithms, Dirichlet problem, E codes, Magnetohydrodynamics, Nonlinear problems, Numerical solution, Tokamak devices, Two-dimensional calculations.
Identifiers: ERDA/990200, ERDA/700105, ELIPTI computer program, *Elliptic differential equations.

The ELIPTI code is designed to solve arbitrary nonlinear elliptic problems over two-dimensional regions of arbitrary shape. This report deals mainly with the basic structure and content of the code to give a potential user immediate access to its use. The essentials of the algorithm it uses are placed in an appendix. A second report will deal with these matters in more detail. Only sufficient results of its use to exemplify its capabilities are given. 9 figures, 2 tables. (ERA citation 02:057826)

UCRL-79328(Pt.2) PC **A02**/MF **A01**
California Univ., Livermore. Lawrence Livermore Lab.
ELIPTI-TORMAC: A Code for the Solution of General Nonlinear Elliptic Problems over 2-D Regions of Arbitrary Shape
J. C. Taylor, and J. V. Taylor. 6 Apr 77, 9p Rept no. CONF-770619-2
Contract W-7405-ENG-48
International symposium on computer methods for partial differential equations, Bethlehem, Pennsylvania, United States of America (USA), 22 Jun 1977.

Descriptors: *Computer codes, Tormac devices, Accuracy, Computer calculations, E codes, Kinetics, Nonlinear problems, Numerical solution, Two-dimensional calculations.
Identifiers: ERDA/990200, ERDA/700105, ELIPTI computer program, *Elliptic differential equations, Partial differential equations, Nonlinear differential equations.

A code (ELIPTI) designed to solve nonlinear elliptic equations over regions of arbitrary shape is discussed. The numerical method is well-known ADI method. The code aims at robustness and ease of implementation consistent with acceptable accuracy and rapidity of convergence. Results of its use are presented in a large set of problems in memory of which comparisons against analytical solutions were possible. 4 figures, 3 tables. (ERA citation 02:055542)

WAPD-TM-1233 PC **A03**/MF **A01**
Bettis Atomic Power Lab., West Mifflin, PA.
REL02: A Monte Carlo Technique to Calculate Failure Probability
D. R. Rauth, and C. M. Smith. Aug 78, 27p
Contract EY-76-C-11-0014

Descriptors: *Computer codes, Failures, CDC computers, Fortran, Monte Carlo method, Probability, R codes, Stresses, Yield strength.
Identifiers: ERDA/360103, ERDA/420500, RELO2 computer program, Normal distribution, Weibull density functions.

The REL02 program uses a simplified Monte Carlo technique to calculate the failure probability of the interaction of two random variates X and Y. Six options are available: Option 1, when X and Y are both normal distributions; Option 2, when X and Y are both truncated normal distributions; Option 3, when X is a normal distribution and Y is a Weibull distribution; Option 4, when X and Y are both Weibull distributions; Option 5, when X is a truncated normal distribution and Y is a Weibull distribution; and Option 6, when X is a truncated normal distribution and Y is a uniform distribution. The average failure probability as well as the density of the failure calculations are available as a listing and graphical plots. 7 figures, 4 tables. (ERA citation 04:006252)

WHAN-IR-47 HC A04 MF **A01**
Wadco Corp., Richland, Wash.
DPB- A DYNAMIC PROGRAMMING CODE FOR OPTIMIZING THE SHORT-TERM OPERATION OF A POWER UTILITY
W. W. Little Jr, and R. W. Hardie. Nov 70, 51p

Descriptors: *Computer programs.

For abstract, see NSA 25 06, number 12919.

Y/DJ-19286 PC **A02**/MF **A01**
Oak Ridge Y-12 Plant, TN.
Sample Size Computer Program for the Hypergeometric
R. W. Counts, and M. W. Sherrill. 1978, 12p Rept no. CONF-780802-1
Contract W-7405-ENG-26
American Statistical Association meeting, San Diego, CA, USA, 14 Aug 1978.

Descriptors: *Computer codes, *Sampling, *Statistics, Hypergeometric functions.
Identifiers: ERDA/990200.

If a random sample of size n is drawn without replacement from a lot of size N, then the number (x) of defective items in the sample follows a hypergeometric distribution. Frequently an attribute sampling plan is desired in which the lot is accepted if the sample of size n contains c or fewer defectives, and otherwise, rejected. Guenther has given a procedure to establish such a plan which will determine the minimum n satisfying both the alpha ("Producer's") risk and the beta ("Consumer's") risk on the operating characteristic (OC) curve. The program given here, which is based on Guenther's procedure, calculates minimum sample sizes for acceptance numbers c = 0 (1) 10 for any lot size between 100 and 10,000. The program allows the user to input values of alpha = 0.001, 0.005, 0.010, 0.025, 0.050, 0.100, 0.200 and values of beta = 0.001, 0.005, 0.010, 0.025, 0.050, 0.100, 0.200. 3 figures. (ERA citation 03:054205)

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